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THE MALAYAN AGRICULTURAL JOURNAL



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SPECIAL RICE ISSUE

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NOTES ON CURRENT INVESTIGATIONS AND EXTENSION WORK, JULY TO DECEMBER, 1958.

MINISTRY OF AGRICULTURE, FEDERATION OF MALAYA,
Kuala Lumpur.

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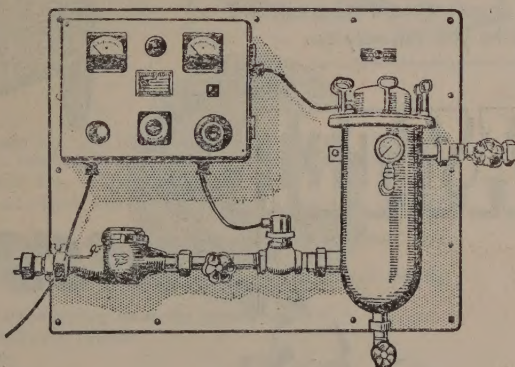
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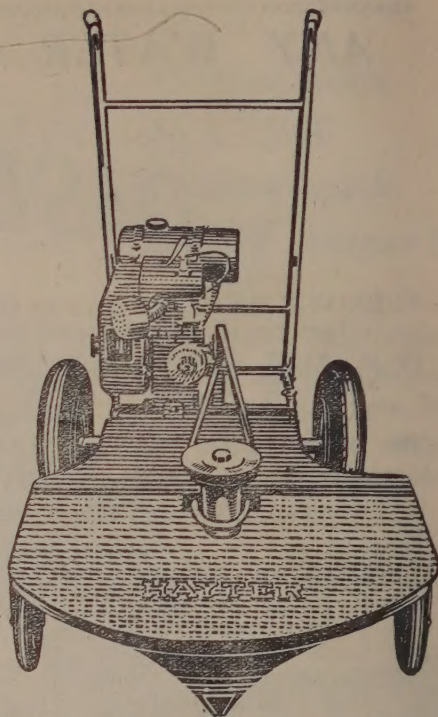
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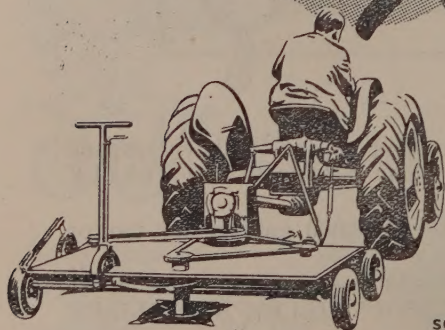
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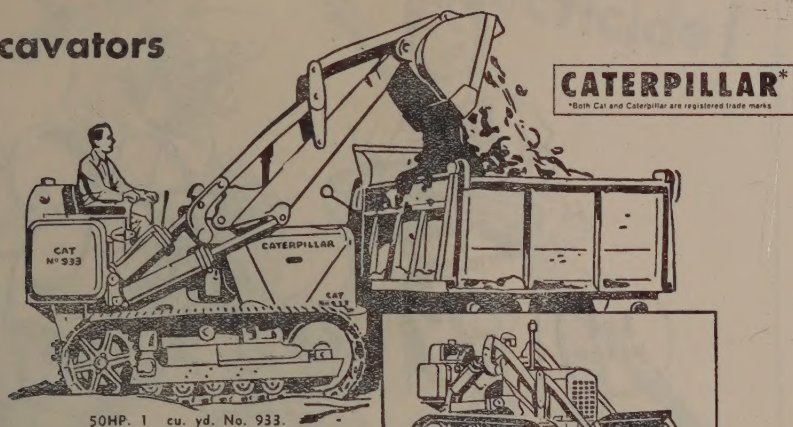
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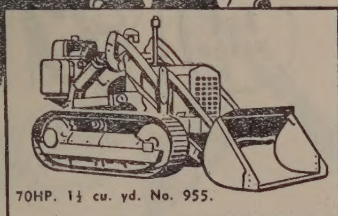
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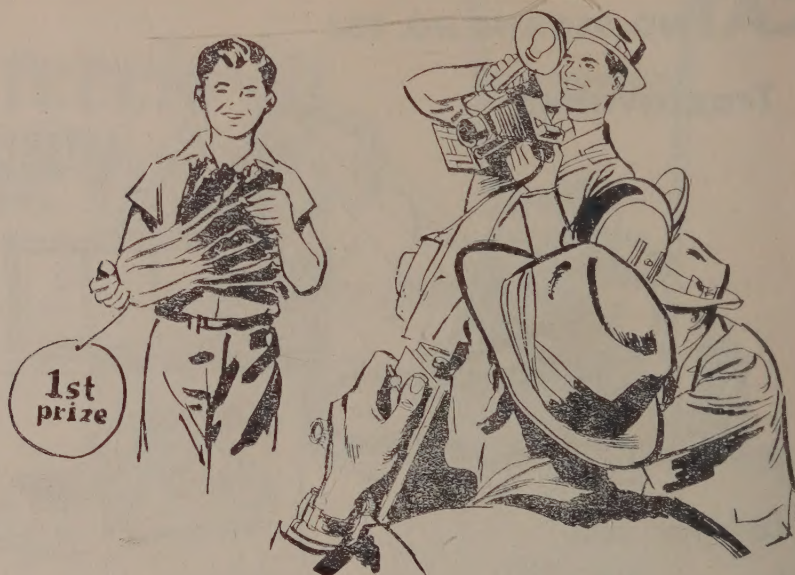


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THE Malayan Agricultural Journal

Edited by the Publications Officer with the Assistance of
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Vol. 41, No. 4.

1958.

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THE MALAYAN AGRICULTURAL JOURNAL

The Journal which is published quarterly, is designed to present — as far as possible in non-technical terms — the results of the agricultural research, investigation and extension work performed by the Department of Agriculture and it draws attention to the results of work of a similar nature in other countries.

The price of the Journal is \$2/- per copy or \$8/- per annum, post free, in Malaya; it is \$8.50 or £1 sterling, post free, outside Malaya.

The Journal and other publications may be obtained from the Department of Agriculture, Kuala Lumpur, Federation of Malaya, or from the office of the High Commissioner for Malaya in the United Kingdom, Malaya House, London, W.1.

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MINISTER OF AGRICULTURE

29th January, 1959.

Message from the Minister of Agriculture

Padi is the top priority crop in the Development Plan of my Ministry. I have given every effort to increase the yield of padi and to do this I have even asked for assistance in the form of experts from Japan in the hope of helping our farmers to increase the yields of their padi and thereby increasing their income. The record yield which has been attained during 1957/1958 season is indeed very encouraging and this shows that our efforts which have so far been directed towards increasing the yield have not been futile. I wish to congratulate all the officers in the Department of Agriculture especially from the Research Division for their untiring efforts in carrying out research in order to increase the yield of padi. However, I wish to stress here that research alone is not enough unless the results of the research are brought to the farmers in the fields in such a manner that they will be fully convinced of the needs to adopt the new ways.

(ABDUL AZIZ ISHAK)
Minister of Agriculture

THE Malayan Agricultural Journal

Vol. 41, No. 4, 1958

EDITORIAL

Rice is the staple diet of the great majority of the inhabitants of Malaya and yet never more than two-thirds of the requirements of the population has been produced locally.

It may be argued from an economic standpoint that it is wiser to produce high-value export crops such as rubber and oil palms and to purchase the balance of our requirements of rice at a low price from neighbouring surplus-producing countries. Nevertheless, the fact remains that much more rice could be produced from the land already devoted to the growing of this crop than is at present being obtained. There is, in fact, considerable room for improvement in output from the existing acreage under padi, without utilising land which might be more profitably employed for the production of export crops.

Economic improvements in yield per unit area can be achieved by a number of means, each individually contributing perhaps only a small increment, but applied collectively, aggregating a substantial increase and resulting in an appreciable raising of efficiency and hence of net return to the cultivator. A composite article in this issue, contributed by a number of officers of the Department, each a specialist in his own line, describes in some detail the various methods of yield improvement applicable to padi growing in this country; all of these have been tried and proved, and it now remains for them to achieve widespread adoption in order that the gap between production and consumption can be further narrowed.

We do not wish to give the impression that the padi planters of Malaya are backward or primitive in their methods; on the contrary, they compare favourably with their counterparts in other tropical rice growing countries and can boast the highest average yields of any such country and, even more to their credit, the greatest rate of yield increase since the war. In substantiation of these claims, the following figures are enlightening:—

Country	Average yield in pounds/acre (season 1956/57)	Increase in Production 1950/55 as compared to 1945/50
Malaya	1,824	+ 25 %
India	1,161	+ 5 %
Indonesia	1,547 *	+ 10 %
Ceylon	1,333 *	+ 6 %
Burma	1,316	— 1.5 %
Pakistan	1,248	— 3 %
Thailand	1,236	+ 0.5 %
Philippines	1,084	+ 5 %

* 1955/56 season.

The 1957/58 wet padi harvest was an all-time record for Malaya and production exceeded three hundred million *gantangs* (755,000 tons) for the first time. This record yield was attributable more to the high national average yield of 2,005 lb. per acre than to the total acreage harvested which, though high at 850,200 acres, was not in itself a record. While it would be idle to claim that this achievement is entirely attributable to the adoption of improved methods and the provision of better water control, the steady improvement in yields during the postwar period must owe much to these factors. The weather is still the most important single factor affecting total production, but even with regular ideal weather conditions, a steady increase in yield is not achieved in the absence of progress in research and extension.

Padi is the Department's top priority crop and constant research, investigation and extension work is aimed at increasing total production and reducing the reliance on imports. From time to time articles on padi have appeared in this Journal describing the results of experiments conducted by the Department and recording the achievements of outstanding padi farmers; special Bulletins have also been produced recording the progress of padi breeding and selection work, agronomic investigations and investigations into the mechanisation and economics of padi production. This is the first occasion, however, on which a whole issue of the Journal has been devoted entirely to this, the most important smallholders crop in Malaya.

In this issue, apart from the composite article on methods of yield improvement already referred to and which is written in non-technical language, there are three scientific articles dealing with various aspects of research on padi.

In the first of these, "Some Effects of Seedling Age on Transplanted Rice" Mr. Brown, who was until recently Senior Botanist in the Department and is now a Rice Expert with the Food and Agriculture Organisation, describes in detail ten experiments carried out at five sites over three seasons with four different varieties of padi. The results show, *inter alia*, that an increase in seedling age increases the total maturation period, decreases the number of tillers and the yield but has little effect on the ripening period or plant height. A positive recommendation arising from the results of these experiments is to the effect that seedlings in excess of 45 days old should not be used for medium and medium short term varieties of 180 and 160 days maturation period respectively. It is also suggested that further investigations should be carried out on the effects of using seedlings less than 35 days old.

Dr. Lockard, in his article on "The Effect of Depth and Movement of Water on the Growth and Yield of Rice Plants" describes three experiments carried out in concrete tanks constructed at the Headquarters of the Department of Agriculture in Kuala Lumpur. These experiments

were designed to provide information upon which to base a programme of research for the new soils/water/plant relationships station which is now nearing completion, and as such may be regarded as of an exploratory nature. However, certain useful conclusions were reached from the results of these experiments, among them being that an increase in depth of water appeared to decrease the number of tillers formed, and hence the yield: also that neither the rate of lateral movement of water, nor the presence of stagnant water had a significant effect on yield, nor did effects of depths or rates differ between varieties. An interesting but unexplained effect was recorded in the differences of behaviour between plants grown in tanks covered with plastic sheeting and plants in uncovered tanks. These tank experiments will be a valuable guide for laying down trials under field conditions when the new station is completed.

"The Fungicidal Treatment of Padi Seed" by Mr. Johnston, formerly Senior Plant Pathologist in the Department but now an Expert with the Food and Agriculture Organisation, investigates the composition of the fungus flora of padi seed in Malaya and reveals that *Helminthosporium oryzae* is not only the commonest fungus present but also the most harmful to young seedlings. Of a number of fungicidal materials tested, it was found that organic mercurial dusts were the most suitable, but laboratory and field experiments showed that no benefit resulted from the treatment of seed which was fresh and gave a high germination percentage. However, improved germination was obtained by fungicidal treatment of seed which was old and of reduced viability.

A publication of the size of this Journal cannot contain more than a few representative articles on any one subject and while we make no claim to having presented a comprehensive review of padi growing in Malaya, it is our hope that we have drawn the attention of our readers to the fact that a considerable amount of our efforts are devoted to this crop.

P. G. COLEMAN,
Ag. Director of Agriculture,
Federation of Malaya.

REVIEW OF METHODS OF YIELD IMPROVEMENT

Introduction

The following collection of notes on methods of improving the yield of Malaya's padi fields, have been compiled by officers working on padi research and agronomy in the Department. The reader will notice that although Malaya is a small country, the padi-growing areas are distributed among a number of different climatic and ecological regions. The differences are not always spectacular but are sufficient to limit any generalisation on methods of yield improvement in the country as a whole. Similarly, differences in day length in the different regions, although consisting of only a few minutes, can substantially affect the time in which crops of different varieties mature. This also has a marked effect on yield, and is discussed below.

No mention is made in this article of diseases of padi. These were covered in some detail in a recent issue,¹ and a separate study on *penyakit merah* by Dr. Lockard will shortly be published.

The use of recommended varieties

The vast proportion of the padi varieties grown in Malaya falls within the indica type. One of the most important characteristics of this type is its extreme photosensitivity. A difference in day length of the order of minutes is sufficient to completely upset the maturation period. In practice, this means that varieties which are suitable for conditions in the north of Malaya are not suitable in, say, Malacca. The result is that in any programme for varietal improvement, a considerable number of varieties and hence a large number of trials must be included. This makes improvement by varietal selection a more complicated and longer term problem than in countries where the varieties do not have this photosensitivity. (Fig. I).

It might therefore appear that the answer to this difficulty would be to grow the non-photosensitive japonica types, but here the question of quality arises. Malaysians prefer and indeed often refuse to eat anything but long-grained non-glutinous rice, so that there is little demand for the glutinous japonica types.

Apart from non-photosensitivity, the japonica types are more responsive to conditions of high fertility and the long term work of the Department on padi breeding is therefore orientated towards producing varieties which continue the best features of both indicas and japonicas on quality, non-photosensitivity and fertility responsiveness.

This is long term work and the padi farmer will not benefit immediately from it. At present he is benefitting from the work on selection of improved strains of local varieties. This line of work was started as early as 1915 and several superior strains were selected before the war but most of these were lost or became completely mixed during

1. "Diseases of Padi" by A. Johnston, *Malay. agric. J.*, 41, 1.

FIG. I
Recommended Varieties
The Progress of Selection

Years 1, 2, 3



Variety Trials
(3 years)

Years 4 & 5



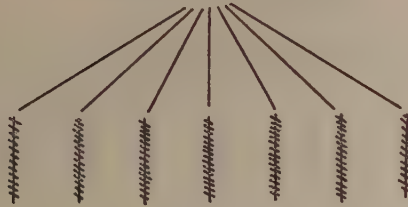
Extension Trials
(2 years)

Year 6



Foundation Stock
(seed of this variety
collected from all
areas where the
variety is grown)

Years 7, 8 & 9



1,000 good strains
(compared for 3 yrs.)

Year 10



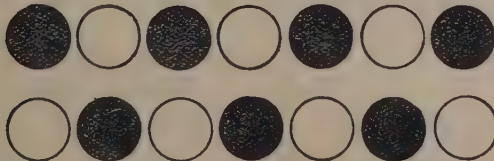
Number of strains
reduced to about 100

Years 11, 12 & 13



Replicated Field Trials
of 40 selected strains
(also quality testing)
(3 years).

Years 14 & 15



Extension Trials and
seed multiplication of
best strains.

Year 16



Seed farms

Year 17

DISTRIBUTION
OF RECOMMENDED STRAIN TO THE FARMER.

the occupation. Work was resumed in 1947 and some of the results are described in the succeeding paragraphs.

The Department has at least one recommended variety for almost every padi area in the Federation and although the increased yield may not always be spectacular the farmer can be sure of a consistently good crop if he follows the recommendations for his area. (Table I).

For example, if farmers in the coastal area of Malacca were to plant the recommended Nachin 39 instead of their own local types, they would get an increase in crop of well over 350 lb. per acre ($2\frac{1}{2}$ pikuls), which is equivalent to about \$36 per acre extra profit.

The recommended variety may have been developed from one of the following three origins.

(i) *Variety Collections and Trials*

All the locally grown varieties, and perhaps also some from other States and foreign countries, are grown in a specially designed trial. After this trial has been grown for at least three years and detailed records of yield, lodging, resistance to disease, etc., have been recorded, the best variety will be tested in "extension trials" on farmers' land for a further two years, before becoming the "recommended variety" for the district. In following years any new variety will be compared with the recommended one. The Department will only change its recommendation when a new variety has been found and proved to be superior in five years of trial.

In the following table some yield results are given from a variety trial planted at Selinsing Padi Test Station in Krian. It was found that Seri Raja gave the highest average yield over the three years and this variety was therefore recommended. These results also show the importance of carrying out a trial for more than one season. In 'Year I', Nachin yielded more than Seri Raja and yet was finally proved to be inferior.

A Trial to Determine the Recommended Variety
(Selinsing Padi Test Station, 1953-56)

Variety	Yield each year (lb./acre)			Average
	Year I	Year II	Year III	
Seri Raja 	1767	2213	1725	1902
Nachin 	2422	1422	1521	1788
Mayang Ebos 	1334	1031	1449	1271

(ii) *Improved Strains*

A recommended variety may give increased yield if an improved strain of the variety is planted. A "strain" of seed all comes from the

Table I

Padi Varieties in Malaya

Region	Varieties Recommended in 1958/59	In Extension Trials now or in a year or two	Observation, or Variety Trials	Now Under Selection
Perlis	M.E. 80, Radin China 4, S.I. 16	R.E. 64	R.E. Selections	—
Kedah	North and Central	Radin Kling		Local and Cuttack Hybrids
	Medium Term:	M.E. 80 S.I. 16	R. E. 64, 41, and Engkatek, Siam 25	R.E. Selections, Sarawak varieties
	Short Term:	Radin Goi	—	—
	Medium Term:	M.E. 80	—	—
	Long Term:	S.K. 48	Seraup 50	—
Province Wellesley	North	Radin Kelombong, S.I. 16	R. E. 64	R.E. Selections
	Central	Off-season:	Pebifun	—
	Main season:	Radin Kling, Bongor, Radin Goi	—	F.A.O. varieties
	South	M.S.B. 8, S.K. 48 and Seri Raja	Seraup 27, 50, 99	—
Penang		M.S.B. 8	—	—
Perak	North Krian	S.K. 48, Machang, Seri Raja, M.S.B. 8	Seraup 27, 50, 99	Seraup Selections
	South Krian	Radin Che Ali, Seri Raja	Seraup 50, 27, 99	Seri Raja Selections
	Central	Seri Raja	—	Seraup Selections
	South (Sg. Manik)	S.K. 48, Pabit, Seri Raja	Seraup 50, 99, 27	Seri Raja Selections
Selangor	Tg. Karang	Radin Kuning	—	Siam Selections
Negri Sembilan		Ser. Kun. 3, 11, 23	Ser. Kun. 30, 48, 60	Ser. Kun. Selections
Malacca	Coastal	N. 57, 39 Siam 29	N. 39	Siam Selections
	Inland	Ser. Kun. 23	Ser. Kun. 21, 23, 30	—
Johore	North	Acheh Puteh	—	—
Pahang	Riverine areas	Ser. Kun. 23	Ser. Kun. 31, 29, 60	Ser. Kun. Selections
	Other areas	Milek Kuning 3	—	Local varieties
Trengganu		P.T. 22, Morak Sepilai	—	—
Kelantan		Mayang Sa Gunpal, Anak Naga, Siam 29	—	—
	Fairly Short Term:	Anak Ikans	—	—
			Introduced varieties from other States	—
			Anak Naga Selections, Sarawak varieties, Cadung Ket	—
			Anak Naga, Mayang Sa Gunpal Padi Tugalan	—

seed of one extremely good plant. The seed from this plant was originally planted in trial with seed from at least one thousand other good plants of the same variety, and over the years the one thousand strains have gradually been reduced until only the very best remain. Finally these selected strains are tested on farmers' land in "extension trials" so that differences between them in response to small variations in local condition, e.g., day length, can be recorded.

The table which follows indicates why the Department of Agriculture recommends that the improved strain "Serendah Kuning 11" should be planted in the Ulu Klawang district of Negri Sembilan. It is much better than unselected Serendah Kuning and slightly better than the other selected strains.

Selection of an Improved Strain
(Ulu Klawang Padi Test Station, 1953-56)

Strain	Yield each year (lb./acre)			Average
	Year I	Year II	Year III	
Serendah Kuning 3	2829	2695	2385	2624
" " 11	2901	2729	2575	2736
" " 23	3034	2255	2469	2586
Serendah Kuning (unselected)	2531	2530	2359	2474

(iii) *New Hybrid Varieties and Strains*

In a few more years, many farmers will be able to obtain from the Department of Agriculture seed which was originally produced by crossing one variety with another. This "hybrid" seed combines some of the good qualities of both parents, but, because the individual plants of a hybrid family differ from one another much more than in a normal variety, it was necessary to select improved strains immediately. These hybrid strains promise to yield more than any other type of seed previously released by the Department. Plates I to V illustrate some of the operations for producing hybrid progeny in the Department's Research Branch, Kuala Lumpur.

Nursery Technique

SELECTION OF SEED

The careful selection of seed from the field for planting the next crop is important to ensure that yield and purity of the variety be maintained. Seed should be dead ripe, well filled and free from disease. It should be true to type and pure for the variety. Care in ensuring that no alien seed is selected cannot be too greatly emphasised. For example, an average plant produces 8 to 12 tillers and each tiller bears about 180 to 240 seeds, so that if seed from one undesirable plant were included for planting one acre, the population of undesirable plants for the next crop would be large.

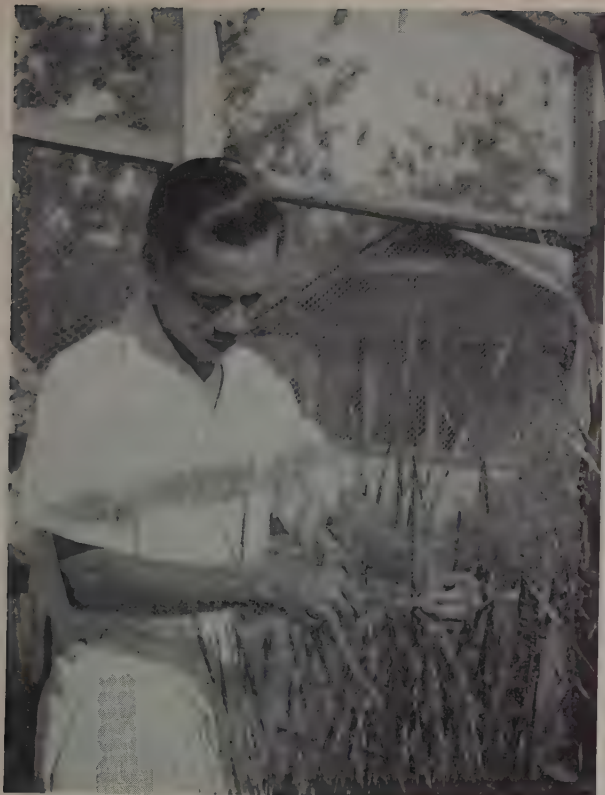


PLATE I

PADI HYBRIDIZATION

Clipping off unsuitable florets from a panicle of a padi plant chosen as the female parent prior to hot air treatment to induce opening of the padi florets.



PLATE II

PADI HYBRIDIZATION

Inserting prepared panicle into thermos flask containing hot air of a required temperature to induce opening of padi florets for emasculation.



PLATE III

PADI HYBRIDIZATION

Emasculation of padi florets which have been induced to open by the "hot air" method. After emasculation pollen from a chosen male parent is brushed on stigma.



PLATE IV

PADI HYBRIDIZATION

Bagging the panicle after artificial pollination to prevent outside chance pollination.

PLATE V



PADI HYBRIDIZATION

Examination of hybrids grown in a protective cage.

PLATE VI



Variety selection (Serendah Puteh) at a Padi Test Station, Negri Sembilan

(i) *In the Field*

An area of about 1/10 of the acreage planted, where the crop is growing well and free from disease is chosen. This area should be constantly rogued during the growing season and at harvest time and any plants not true to type discarded. At harvest time, the edge plants are discarded and the rest harvested for next year's seeds.

Another method is to go round the field with the *tuai*, (small knife), at harvest time and gather seed from those plants with good ears and true to type. It is advisable to avoid edge plants in order to ensure that seed is not selected from chance cross-pollinated plants. Seed from 250 plants should be ample for planting-up one acre.

After harvest, precautions should be taken to safeguard the seed from contamination. Equipment used for handling the seed should be clean and free from alien grains. The seed should be thoroughly sundried before storage.

(ii) *After winnowing*

The collection of ears for seed purposes, no matter how well it is carried out, will inevitably result in the inclusion of a certain percentage of light-weight seed. When the grain is removed from the ear these light grains after winnowing can be separated by the technique known as flotation. A salt solution of specific gravity 1.13 is prepared. An approximate determination of this specific gravity can be achieved by dissolving salt in water until a fresh hen's egg floats half in and half out of the brine. The padi seed is then added and stirred gently. Well-filled, heavy grains will sink, but the light-weight seed floats on the surface. The 'floaters' should be scooped off the surface and the selected heavy seed removed from the brine and then washed twice with fresh water to remove all trace of salt.

SEED RATE

The actual seed rate will depend on the proposed planting density in the field. A seed rate of two to three *gantangs* (gallons) of good brine-selected seed per acre is adequate for all present recommended planting densities.

TREATMENT OF SEED

Pre-germinated seed should be used when sowing a padi nursery. Such seed develops more quickly and this minimises the damage which can be caused by birds or flood water. Pre-germination is achieved by soaking the seed in fresh water for 24 hours, draining off this water and then spreading out the seed in a thin layer in a shady spot on sacking. The seed is then covered with another piece of sacking and this is sprinkled with water periodically during the next 48 hours in order to keep the seed damp and thereby encourage germination.

SELECTION OF NURSERY SITE

The selection of a site for the nursery is very important no matter what type of nursery is being used. It is important to select an area

which is unshaded and where the soil is the best available. Cultivation and preparation of the nursery bed needs to be carried out early and should be completed before the gazetted sowing date for the particular area. Cultivation must be more thorough than that for field preparation in order to ensure an adequate depth of uniformly textured soil.

TYPE OF NURSERY

There are three main types of nursery at present in use in Malaya:—

- (a) The wet nursery
- (b) The rakit nursery.
- (c) The dry nursery.

(a) *Wet Nursery*

This type of nursery is considered to be the best. In selecting the site for a wet nursery it is essential that the soil can be rendered dead level in order to ensure perfect control of the height of water. It is advisable to incorporate in the nursery well rotted, dry cattle or buffalo manure. This should be applied at a rate of not less than one pound per square foot of nursery bed and must be evenly spread and thoroughly worked into the soil. Beds should be constructed about 4 to 5 ft. wide but may be as long as convenient. Each bed should be surrounded by small bunds to assist local water control. Access paths should be left between nursery beds when these are adjacent to enable sowing and other operations to be carried out from both sides of the bed. The final cultivation is the puddling of the soil and its very careful levelling to ensure that a flat surface is achieved. It is at present recommended that ammonium phosphate 11 : 48 is broadcast on and lightly worked into the prepared surface of the nursery bed at the rate of 2 lb. per 500 sq. ft. In order to assist even distribution of this fertiliser it is advisable to mix it with twice its weight of dry, free-flowing river sand. Under no circumstances should sand containing salt be used.

Prior to sowing, the water table must be maintained just below the surface of the soil, in such a way that the surface of the bed is kept in a very damp condition. On the gazetted sowing dates pre-germinated seed should then be broadcast over the surface of the prepared nursery bed at the rate of one *gantang* per 500 sq. ft. of bed. It is most important to ensure an even scatter of seed and for this reason half the width of the bed is sown from each side. Once the seedlings are established, water can be introduced and the depth very gradually increased as the seedlings develop.

(b) *Rakit Nursery*

The rakit nursery consists of a raft, usually constructed by piling cut grass and weed and placing on this a few inches of soil. This type of nursery is used only when the water is too deep to permit the use of the recommended wet nursery. It is a technique that is at present

unavoidable in certain districts, e.g. Krian. Pre-germinated seed is sown on the rakit and remains there until tall enough for first transplanting, i.e. 5 to 6 in. tall. The seedlings are transplanted in small clumps into a prepared area of the field in which the water is shallow. This in effect constitutes a second nursery and the seedlings from this area are those which are eventually planted in the field.

The soil used in the rakit nursery should be not less than 3 in. deep and should be evenly and thoroughly mixed with well rotted, dried, cow or buffalo manure. 50 sq. ft. of this nursery is usually used for sowing one *gantang* of seed. Before sowing the seed, $\frac{3}{4}$ lb. ammonium phosphate 11 : 48 per 50 sq. ft. of rakit is broadcast over the surface of the soil and lightly worked in. The seed is then broadcast evenly and allowed to grow until sufficiently tall for transplanting. The second nursery is of course under water but so far as is possible it is prepared in a manner similar to the wet nursery. It is not, however, manured with fertiliser prior to transplanting. Instead $1\frac{1}{4}$ lb. of ammonium phosphate 11 : 48 diluted with river sand is applied immediately after transplanting to the seedlings from 50 sq. ft. of rakit.

(c) *Dry Nursery*

The dry nursery is used in areas where irrigation depends on rainfall and the latter is usually inadequate prior to transplanting, e.g. in the monsoonal State of Kelantan. It is at the present time considered to be a less desirable technique than the wet nursery but a great many of its deficiencies can be overcome by good husbandry. The site selected for a dry nursery should, as far as possible, be level and close to a source of water. A nursery area of 500 sq. ft. is recommended for every *gantang* of seed to be sown. A dressing of dry, well rotted cow or buffalo dung must be evenly applied and thoroughly mixed with the soil at a rate of not less than 2 lb. per sq. ft. of nursery. Beds are prepared of 5 ft. width and of any convenient length in the same manner as those of the wet nursery. It is thought that double superphosphate may be beneficial if raked into the surface of the nursery bed and 10 lb. per 500 sq. ft. of nursery is the suggested dressing. Pre-germinated seed is broadcast and watered in. It may be necessary to water the seedlings periodically if rainfall is inadequate.

NURSERY MANAGEMENT

All three types of nursery need to be protected from domestic livestock by a strong fence and from attacks by rats and birds. Rats may be controlled by the use of poison baits, e.g. zinc phosphide mixed with boiled grains of padi and placed in heaps at appropriate points within the fenced area. Various devices may be used to scare birds. Perhaps the most effective are the use of thin strips of tin tied to strings which produce a jangling sound and the fixing of black thread criss-crossing just above the seed bed.

Weeding of the nursery is the most important post-sowing operation. It can only be done by hand and as great care is necessary it should be carried out from both sides of the bed.

Land Preparation

The object of cultivating wet padi land is:—

- (i) To clear and bury rice stubble and weed growth,
- (ii) To enable land levelling to be carried out,
- (iii) To produce soil conditions suitable for transplanting rice.

Methods of land preparation employed in the Federation vary from cultivation by hand through a mixture of hand and animal drawn implement cultivation, to cultivation entirely by animal power. In some parts of the Federation there is limited use of mechanical cultivation by light tractors, but the area of land suitable for such methods is not extensive.

Throughout the major padi growing areas of the Federation, the dates for starting cultivation, for sowing of rice nurseries, for transplanting seedlings and for weeding the growing crop are laid down by Gazette notification. The dates are fixed in relation to the probable availability of water, either natural rainfall or irrigation supply. The importance of adherence to the gazetted dates is great, especially in relation to irrigation. Failure of rains and shortage of water is not uncommon, and in such circumstances cultivations and planting may be seriously delayed.

While initial cultivations, especially ploughing by animal or tractor drawn ploughs, can be carried out in dry conditions, subsequent cultivations, such as harrowing and rolling, are best carried out with water on the land, conditions which facilitate weed suppression. Final preparation of the land for transplanting must be carried out in the wet.

The importance of land levelling cannot be too greatly stressed. The yield of rice is dependant largely on water levels throughout the growing period, and high or low spots in the field, where water is either too shallow or too deep, can cause significant reductions in yield. Weed suppression is assisted by water depth, and in shallow areas weed regeneration may be rapid. It is considered that the optimum depth of water at transplanting is three inches; if it is deeper early tillering is inhibited, if shallower weed suppression is reduced.

Transplanting

Time of transplanting is an important feature in the cultivation of padi. Seedlings are ready for transplanting into the field when five to six leaves have formed. This varies according to the time the padi variety takes to mature and the following data is offered as a guide:

<i>Maturation Period</i>	<i>Optimum Time for Transplanting</i>
140 days or less 	20 - 25 days after sowing
140 - 180 	25 - 35 " " "
180 - 200 	35 - 40 " " "
200 or more (including floating nurseries) 	40 - 50 " " "

The potential yield of seedlings is unavoidably depressed if they are transplanted at a later stage from that outlined. Experiments have

proved that the effect becomes increasingly marked the older the seedlings become (cf. pg. 221), hence if for one reason or another it is not possible to transplant at the optimum stage, it may be better to resow the nursery with a slightly shorter term variety and transplant this at the optimum stage of development.

Wherever possible gazetted planting dates should be adhered to. The transplanting of padi on dates very different from those gazetted can and does result in a reduction or—in extreme cases—a total loss of yield.

It is most important to prevent bruising of the foliage at the time of transplanting. To avoid bruising when removing seedlings from the nursery it is advisable to use a trowel or similar implement to lever up the seedlings assisting this with a gentle pull of the bunched leaves. The mud or soil adhering to the pulled seedlings should be washed away carefully but seedlings should not be beaten in the process. The bundles should be tied as near as possible to the roots to prevent bruising of the foliage. If the seedlings are very leafy their tops may be removed with a sharp knife to allow them to 'stand up' better in the field and reduce transpiration loss.

It is important to ensure that the seedlings are not pulled and bound roughly. The bundled seedlings should be transferred carefully to the padi field and transplanted as quickly as possible to avoid excessive moisture loss.

SPACING

Optimum spacing varies according to the maturation period of the padi variety used and the fertility of the soil. Experience suggests that the following data might be considered as a general guide:

- (a) The shorter the maturation period of the variety used the higher the plant population per unit area recommended:

Short term varieties	9 in. x 9 in.
Medium term varieties	12 in. x 12 in.
Long term varieties	15 in. x 15 in.

- (b) The lower the fertility of the soil the higher the plant population per unit area recommended:

Low fertility	6 in. x 9 in.
Medium fertility	12 in. x 12 in.
High fertility	15 in. x 15 in.

It will be appreciated that this data is only offered as a guide and may be influenced by other factors, e.g., depth of water.

It is important when transplanting at any specified spacing to ensure that accurate and regular spacing in straight lines is adhered to. The accurate planting of seedlings greatly facilitates uniform growth of the padi and post-planting cultivation.

PLANTING TECHNIQUE

Two to three seedlings should be planted per hill. The seedlings should be planted as shallowly as possible as this promotes early tillering

upon which high yield depends. They should also be planted upright as this promotes even tillering around the hill.

Field Manuring

The manuring of padi in the field in Malaya presents a number of problems peculiar to this country. Padi soils in Malaya are usually acidic in nature, frequently deficient in bases and of variable inherent fertility. Furthermore, padi husbandry techniques vary considerably in their efficiency, as a consequence of the differing importance of padi in the peasant economy from one region to another and the facilities for irrigation. In some areas padi is the major source of income, in others it is of only incidental importance. Irrigation schemes are playing an increasingly important part in many padi areas but it remains a fact that the majority of padi is still grown in areas which rely on rainfall as their only source of water.

These features would be of less importance if it were feasible to define substantial areas where all conditions are reasonably uniform. It has not been possible to do this, however, and in consequence response to field manuring has proved to be very variable. Investigations designed to elucidate the manurial requirements of padi in different areas have been carried out for over 30 years. Important and valuable results have been obtained from these trials but variability in response has defied their proper interpretation. Extension trials designed to investigate the causes of variability have emphasised the need to standardise husbandry techniques before proceeding further with fertiliser investigations. This is now in progress but in the meantime valuable general advice can be and indeed is offered to the farmer as a guide.

Perhaps the most important aspect of peasant farming in Malaya is the advantage which can be achieved by adopting a sound system of husbandry. It is usual in many areas to grow one crop of padi per year and to allow the land to lie fallow between crops. In some areas shortage of water makes such a system inevitable but in others where water is available, double cropping is successfully practised, while in others a form of rotational cropping is the rule. There is little doubt that the latter system, which consists largely of growing vegetable crops in the off season, is particularly beneficial. The fertility of the soil is markedly improved as a result of manuring the off season crops. The latter are usually high value crops which permit far greater expenditure on manures, thus improving the fertility of the soil much more rapidly than is possible if padi alone were to be grown.

In many areas and particularly in those where rotational or off season cropping is not practised, it is desirable that animal manure in some form or another be ploughed into the land annually with the first cultivation. The use of inorganic fertiliser is recommended whether animal manure has been applied or not but it will be appreciated that fertiliser alone is not an adequate substitute for organic matter. The very acid nature of many padi soils prevents the effective utilization by the plant of nutrients which would otherwise be available. This harmful

effect can be counteracted by the addition of limestone. Trials have indicated that responses in terms of increased padi yield can be expected in many areas as a result of such treatment.

In most areas an economic response in terms of increased grain yield can be expected as a result of the judicious use of fertiliser. Recommendations will, of course, vary according to the area, soil type and method of irrigation, etc. Nitrogen and phosphorous are the two most important major nutrients lacking in the padi areas of Malaya. Due to the very heavy rainfall any nitrogen not taken up by the plant is soon leached out of the top soil and subsequently changed into nitrogen gas. Phosphate may be present in considerable amounts in the soil but this is often locked up in a form unavailable to the plant. The need for potassium has not as yet been clearly demonstrated. It is thought to be beneficial in areas of sandy soil and it is often included in small quantities in general fertiliser mixtures as an insurance measure. Other plant nutrients are generally present in adequate amounts and need not be used unless a definite deficiency is shown to exist.

Nitrogen is required in most areas for high padi yields. Where it is needed it should be applied to each crop. Both nitrogen and phosphate increase padi yields but increases are greater when both are applied together than when applied separately (Plates VII, VIII). Where light applications of phosphate are made they should be applied every season; where heavy rates are applied they may last over several seasons as there can be a residual effect from heavy phosphate applications. So far as we are aware at present, light annual dressings are preferable. It is likely that application of phosphatic fertiliser will pay dividends only when adequate nitrogen is used. Where phosphate is needed and stimulates plant growth, a large amount of nitrogen is often necessary to obtain maximum yields. In areas of particularly poor phosphate-deficient soil it is important that nitrogen should not be applied if the land has not already received a basal application of phosphate.

NITROGEN

Nitrogen-deficient plants are characterised by a yellow-green appearance. Only nitrogen in the ammonium form should be used for padi growth under continuous flooding, because only in this form, when properly applied, can nitrogen be retained in flooded soils until utilized by the padi plant. The correct application of ammonium nitrogen is extremely important. If it is not properly applied it will first be converted to nitrate nitrogen and subsequently broken down to nitrogen gas.

Padi soils have two very different layers in respect to nitrogen transformation. Immediately beneath the water in flooded soils is a very thin layer of soil, not more than a quarter of an inch deep, where oxygen is present. Any ammonium nitrogen occurring in this zone, if not quickly utilized by the plant, is changed to nitrate nitrogen. This is leached deeper into the soil and converted into nitrogen gas which subsequently escapes to the atmosphere and is thus lost to the plant.

Oxygen is not normally present in the soil below the thin surface oxidising layer, so when ammonium nitrogen is placed two to three inches deep into the soil the nitrogen will not be changed and it will remain readily available to the padi plant.

There are two methods of application which ensure maximum utilization of ammonium nitrogen:

- (1) Incorporation with the soil below the oxidising layer, normally before transplanting.
- (2) Application, as a top dressing, to the padi at the tillering stage.

The loss of nitrogen, when it is applied as a top dressing at the tillering stage, is very small. At this stage in the growth of the padi plant surface roots are developing and growing quickly and nitrogen is rapidly absorbed by the plant. It is recommended that most, if not all, the nitrogen be applied as a top dressing, the actual time of application varying with the maturation period of the padi. The following times are offered as a rough guide:

150 days or less		5 weeks after transplanting
151 - 190		6 " " "
191 - 220		7 " " "
220 or more		8 " " "

NOTE: Top dressing with nitrogen after the stipulated time will not appreciably improve yields, though it may improve the appearance of the crop.

The following fertilisers are at present available in Malaya and are recommended as sources of ammonium nitrogen.

- (a) Sulphate of Ammonia (21%N). A fine crystalline material, normally white in colour.
- (b) Urea (45%N). The use of granular coated urea is recommended as it is less hygroscopic and can be stored more easily than the crystalline form. Coated urea is usually white or pink in colour. Prilled (finely pelleted) urea (46%N) is also used on occasions.

The amount of nitrogen needed depends on several factors, such as inherent fertility, the amount of organic residue returned to the soil, the use of phosphate, the season etc., but during a favourable growing season, it is usually profitable to add in total, 20 to 40 lb. of actual nitrogen per acre.

Nutrient rate per acre (lb.)		20 — 40
Fertiliser rate per acre (lb.)		
Sulphate of Ammonia		95 — 190
Urea		44 — 89

It is important to avoid providing an excess of nitrogen, as it is not only uneconomical but may seriously reduce yields by causing excessive vegetative growth, lodging and late maturity.

PLATE VII



Jintan Manis variety growing with the 2.2.1 dressing (i.e. an inorganic fertiliser containing, nitrogen, phosphate and potash (K_2O)). It yielded at the rate of 1164 lb. per acre.

PLATE VIII



Jintan Manis variety growing without manure. The padi is not very tall and is later coming into ear. It yielded at the rate of 720 lb. per acre.



Experiments conducted initially in tanks to find the effects of fertiliser on the yield of padi.

PLATE X



Demonstration plots of manured (right) and unmanured padi at Kuala Pilah, Negri Sembilan.

PHOSPHATE

Phosphate-deficient plants are difficult to distinguish from nitrogen-deficient plants. Spindly, unthrifty, erect plants with narrow leaves and few tillers are usual symptoms. When plants lack both phosphate and nitrogen, the seedlings lack vigour, tillering is poor, time of flowering and maturity is delayed and yields are reduced. Padi plants require phosphate throughout their whole growing period and the need increases as the plant grows older.

The following phosphate fertilisers are available and all are satisfactory sources of phosphate for padi fertilisers:

- (a) Christmas Island Rock Phosphate (36% P_2O_5).
- (b) North African Rock Phosphate (30% P_2O_5).
- (c) Superphosphate (18% P_2O_5).
- (d) Double Superphosphate (40% P_2O_5).
- (e) Bat Guano (The phosphate content is variable but an average figure is about 10% P_2O_5).

On most padi soils in Malaya dressings of 30 to 60 lb. actual P_2O_5 per acre are considered satisfactory.

Nutrient Rate per acre (lb.)		30	—	60
Fertiliser Rate per acre (lb.)				
Christmas Island Rock Phosphate		83	—	167
North African Rock Phosphate		100	—	200
Superphosphate (18%)		167	—	333
Double Superphosphate (40%)		75	—	150
Bat Guano (Approx. 10%) approx.		300	—	600

Phosphate applied but not utilised by the crop will have a residual benefit on subsequent crops. It is possible to restore the supply of phosphate in a phosphate-deficient soil. Large annual applications are required initially and when the deficiency has been corrected, smaller applications will probably be adequate to maintain the supply. On the west coast, rock phosphate is generally the most economical source of phosphate while on the east coast double superphosphate (40%) is more often profitable.

Because of the padi plant's continuous and increasing need for phosphate, the supply should be placed in the root zone before transplanting; the fertiliser should be incorporated with the soil to a depth of two to three inches during the course of the final cultivation.

POTASH

This nutrient is thought to be beneficial in areas of sandy soil. An application of 15 to 30 lb. K_2O per acre applied prior to the last cultivation is recommended. Potash is normally applied in the chloride form, i.e., muriate of potash, as this is cheaper and equally as effective per unit of K_2O as other potash fertilisers.

COMPOUND FERTILISERS

In addition to those fertilisers mentioned above, there are available on the market combined nitrogen and phosphate fertilisers of the mono-

ammonium-phosphate (11 : 48 : 0) and ammonium sulphate-phosphate (16 : 20 : 0) groups. They are sold under various trade names and under certain circumstances are also satisfactory for padi manuring. They should be applied before transplanting and may be incorporated into the soil at the rates suggested.

FERTILISER RECOMMENDATIONS

Present fertiliser recommendations are available for most of the main padi areas of Malaya and these are listed below. These recommendations are based on experience to date and will be amended as new or improved mixtures become available or as the results of trials indicate a more profitable nutrient rate.

State	District	Nutrient N	Rate P ₂ O ₅	lb./acre K ₂ O	
Perlis	2nd & 3rd Class Land	30	60	—	
Kedah	2nd & 3rd Class Land	30	60	—	
Penang	Province Wellesley				
	North & Central	30	60	15	
Negri Sembilan	All padi areas	30	45	15	
Malacca	All padi areas	30	40	15	
Kelantan	All padi areas	24	24	12	Sold as a complete mixture—Baja Padi—to be applied in two doses of 100 lb./acre; before transplanting and again six to eight weeks after transplanting.
Trengganu	Batu Rakit	—	40	—	P ₂ O ₅ as Double Super-phosphate.
	Other padi areas	24	24	12	As for Kelantan.

NOTE: Economic response to recommended application of fertiliser can be anticipated only if optimum management/growing conditions prevail. Fertiliser cannot be expected to take the place of good management.

Fig. II illustrates the response that can result from fertiliser application and it also shows something of the variation that occurs from area to area even within one State.

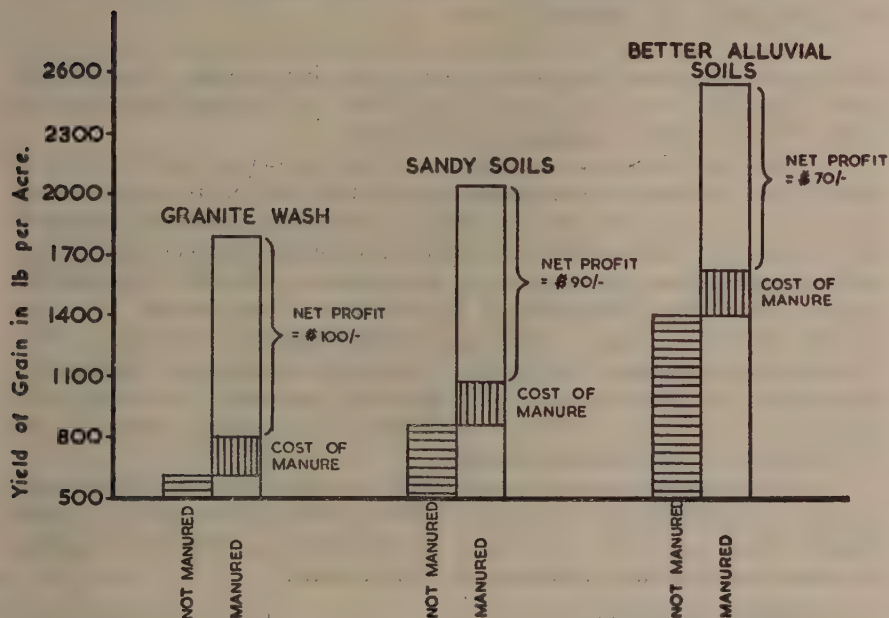
Weed Control

The control of weeds is an essential factor in successful cultivation. Weeds compete with the crop for nutrients, water and light; and they may act as hosts for diseases and pests which attack the crop.

Preliminary cultivations of rice fields are designed, among other things, to effect control of weeds. Annual and perennial dry land weeds, both grasses and broad leaved species, are killed when water is admitted to the land, but aquatic and semi-aquatic weed species will not be killed by wet conditions. Such weeds are controlled by land preparation cultivations, but subsequent regrowth has to be removed by hand weeding in the growing crop.

FIG. II

RESPONSE TO "BAJA PADI" AT 200 LB. PER ACRE ON
THREE SOIL TYPES IN KELANTAN.



The depth of water in rice fields is an important factor in weed control. Dry land weeds are killed when water is admitted to the field, and many semi aquatic species are controlled by varying the depth of water, although the actual depth of water that can be permitted is dependant on the stage of growth of the crop, and is essentially a compromise between the depth sufficient to give good control of weeds and that shallow enough to permit vigorous tillering of the young rice plants.

The off-season cropping of rice land helps in the control of weeds. When an off-season rice crop is taken, off-season weed growth is reduced, and some species may in fact be totally eliminated, there being insufficient time available with the land unoccupied for their life cycle to be completed. Off-season cropping with dry land crops, such as is practised in parts of north and central Malaya, results in the elimination of many aquatic weeds.

Experiments have indicated that some common weeds of rice fields may easily be controlled by the use of selective herbicides, including the salt and iso-butyl esters of M.C.P.A., and the salt and ester form of 2,4-D. Although the common sedge, *Scirpus grossus* is fairly susceptible to selective herbicides, grass weeds of rice fields do not appear to be. The water hyacinth, *Eichhornia crassipes*, is susceptible to the acid or ester form of 2,4-D, and in some parts of the Federation the weed is now controlled by spraying with 2,4-D sodium salt. (Plate XI).

Pests

Though the majority of the pests of padi are insects, rats also cause considerable damage in practically all areas and crabs may be quite destructive in localised areas.

During the past few years considerable research has been done on stem borers, which are the most serious of the insect pests. Counts have shown that 50 per cent or more of the tillers can be bored and that the areas of most serious damage are in Krian.

Stem borers are a problem in all rice growing countries but in Malaya the problem is complicated by the fact that in the areas where stem borers are most serious, i.e., Krian, fish are an extremely important part of the cultivators' livelihood and most of the modern insecticides are as toxic to fish as they are to stem borers. Another complicating factor is the great variability in the severity of the attack. In some seasons attacks are light so that spraying would not be economic. Thus a considerable amount of attention is being paid to methods of predicting the severity of borer attack. This has been successful in Japan but is likely to be much more difficult in Malaya, since borer incidence does not conform to any regular pattern.

In the succeeding paragraphs brief descriptions of the stem-borers are given and some of the trials on their control are described. Other insects which are often of serious consequences in restricted localities are also described and methods of control noted.

STEM-BORING CATERPILLARS

Stem-boring caterpillars, (*ulat batang*), are larvae of moths which lay eggs on the leaves or inside the leaf-sheaths of the plant. Shortly after hatching the caterpillars bore into the padi stem and for most of their life they remain in the stem feeding on the tissue and either killing or injuring the plant so that it produces little or no crop or empty "white ears". Pupation takes place inside or outside the stems at the base. Several generations occur each year and these generally overlap each other. A complete life-cycle occupies seven weeks of which five are spent as the larval stage. Four species of stem-borers of major importance in Malaya are:—

1. *Chilotraea polychrysa* Meyr.
2. *Chilo suppressalis* Walk.
3. *Schoenobius incertulas* Walk.
4. *Sesamia inferens* Walk.

Once they are within the padi stem, stem-borers are extremely difficult to control.

Today, the problem of controlling the stem-borers is being investigated in all padi-growing countries where the stem-borer is a pest. In some countries, e.g. Japan, stem-borers are controlled by the use of parathion and Folidol (EPN 300) which are not used in Malaya because of their high mammalian toxicity. None of the insecticides (DDT and dieldrin) tried in Malaya so far, give any substantial measure of control

of the pest. Other insecticides under trial include Diazinon, Malathion and Rogor 40.

In Malaya, attempts to control stem-borers by using biological agents date as far back as 1931, when such parasites as *Trichogramma japonicum* Ashm. were introduced in the field. Unfortunately the parasites did not establish themselves.

Control by flooding, crop rotation and collection of egg-masses are not practised in Malaya.

SUCKING BUGS

Several species of sucking bugs may cause damage to the padi crop in Malaya. They are:—

1. *Leptocorisa acuta* Thunbg. (*Pianggang*)
2. *Scotinophara coarctata* Thunbg. (*Kutu bruang*)
3. *Sogata furcifera* Horv. (*Bena puteh*)
4. *Nephotettix bipunctatus* F. (*Bena hijau*)

Leptocorisa acuta is a pest only during the grain-developing stage of the padi crop. It feeds on the milk-ripe grains, sucking the contents until only empty seed coats remain.

The adult bug is a long greenish-brown insect with slender antennae and legs. Females lay their eggs in regular rows usually on the upper surface of padi leaves close to the mid-rib. Nymphs emerge in about a week and after sucking the leaf-sap for about two days, climb into the panicles. Here they continue to feed and in about three weeks they reach the adult stage. If disturbed, the adults fly (young bugs are wingless) for short distances and again settle on developing grains.

Leptocorisa acuta can be effectively controlled by fogging with DDT or dieldrin. This must be carried out early in the morning or in the evening. A simple method of control is by using nets to trap adults or waving branches or any other suitable implement smeared with sticky substance over the padi ears.

Scotinophara coarctata is a bug which in its adult stage is about 8 mm. long, elliptical in shape and black in colour. The eggs are greenish or pinkish in colour, measuring about 1 mm. long and 0.9 mm. broad, and are laid in masses at the base of the plants. Eggs hatch in about six days and the life-cycle is completed after about one month. Nymphs and adults feed by sucking, generally at the base of the plant, causing it to be stunted.

One of the following methods of control may be applied:—

1. Apply a mixture of equal parts of 5 per cent DDT and 0.65 per cent gamma BHC dusts.
2. Raise the water level in the padi field for two to three days to kill the bugs, which often remain at the base of the plant.
3. Turn ducks into the padi field. Ducks eat these insects.

Nephotettix bipunctatus and *Sogata furcifera* are commonly known as leaf-hoppers. *Nephotettix* is entirely green except that the male has two black dots on the wings. The adult is about 4 mm. long. *Sogata* is dirty white in colour, very small, i.e. about 3 mm. long.

Nymphs and adults of both species feed by puncturing the leaf-sheaths, sucking the sap and leaving the leaves to dry up. With young plants, the attack can be very serious.

Nephotettix lays her eggs in leaf-sheaths. These hatch after about six days and the nymphs become full-grown adults within 20 days.

Sogata lays her eggs in slits in the mid-rib of leaves. Nymphs emerge after about three days and reach the adult stage after about three weeks.

Both species may be controlled by applying a 5 per cent DDT dust at the rate of 20 lb. per acre using a duster.

Shaking the pests into water covered with a film of kerosene is also practicable.

Another simple method of control is to drain off water from the field for two to three days.

LEAF-EATING CATERPILLARS

Damage to the padi crop by these caterpillars is either by consumption of the leaf or, after cutting and folding or rolling the leaves, by eating the tissue.

These caterpillars are the larvae of the following species of lepidoptera:—

1. *Spodoptera mauritia* Boisd., or Armyworms
(*ulat ratus* or *ulat ribu*)
2. *Cnaphalocrocis medinalis* Guen. (*ulat gulong*)
3. *Nymphula depunctalis* Guen (*ulat hampong*)

Spodoptera mauritia is the worst of the swarming caterpillars attacking padi in the nursery. Very severe damage can be caused as the caterpillars migrate from field to field and frequently are not noticed in the early stages when the leaf tips are only scraped before the leaf blade is consumed.

Early dusting with 5 per cent or 2½ per cent DDT at about 25 lb. per acre gives good control. One pound of the dust will treat a nursery of 20 *gantangs* of seed. It was found that when wood ash was used the injured nurseries recovered quicker than with talc; best results were obtained in hot sunny weather. In the field it may be a pest of dry padi.

Cnaphalocrocis medinalis is a minor pest of padi in Malaya. The caterpillar lives between the folded leaves and feeds on chlorophyll of the leaves. A full-grown caterpillar is about 15 mm. long, yellowish-brown in colour and with a brown head.

If control measure is necessary, hand-picking is usually sufficient. A 5 per cent DDT dust gives effective control of this insect.

Nymphula depunctalis caterpillar is semi-aquatic. It lives in a tube made of rolled pieces of padi leaf which is filled with water.

The caterpillar may cause considerable damage to young padi plants by feeding and cutting the leaves. The eggs are laid in masses on padi leaves, each egg measuring about 0.5 mm. x 0.8 mm. It is oval, flat and pale yellowish-green in colour. Eggs hatch in about three days and the larvae become full-grown in about 17 days, after which they

PLATE XI



Applying selective herbicides to young padi with a 12 ft. boom attached to two pressure retaining knapsack sprayers.

PLATE XII



A Departmental "Swingfog" pest control unit in action against padi bugs (*Leptocoris* spp).

PLATE XIII



Rat trap using wood block)

PLATE XIV



Rat destruction (zinc phosphide in bamboo)

PLATE XV



Rat destruction (zinc phosphide in *rumbia* (sago palm)
sheath)

PLATE XVI



Harvesting padi ears with a *tuai*.

pupate and emerge as adult moths in about one week. A fully grown caterpillar is about 10 mm. long, yellowish-grey in colour and with a green head.

Nymphula can be controlled by draining off the water in the affected field for two to three days or by an application of kerosene to form a thin film on the surface of the water (1 to 2 gallons per acre).

RATS

Rats can be a serious menace to rice production for they not only destroy the growing crop by gnawing the stems and eating the developing grains but they may also feed on stored padi and rice. The rat population is dependent on the amount of food available, i.e., the more the food, the bigger the population.

In Malaya, work on controlling the rat menace is undertaken by the Rodent Destruction Staff of the Field Branch in the States. Several types of rat poison are available but the main one which is supplied free of charge to the padi-planters is 2½ per cent zinc phosphide. The poison is mixed with a bait and the mixture is placed at suitable points in the attacked areas. Simple rat traps in general use are illustrated in Plates XIII, XIV, XV.

Harvesting and Storage

As it ripens, the rice head necks over, and the grains turn a brownish yellow colour. The grain is harvested as soon as possible after it is fully ripe, for shattering and consequent loss of grain follows rapidly after the stage of full ripeness.

There are two methods of harvesting in the Federation, by the use of the *tuai*, and by sickle. The *tuai* is a small knife, set in a shaped piece of wood, which fits into the hand and with it individual heads of padi are cut (Plate XVI). When harvesting with the sickle, the whole rice plant, including the major portion of the straw, is cut. Harvesting with the *tuai* is a slow process, as each head must be selected and cut individually, but its advantage is that the harvester is able to cut only heads which are fully ripe, and leave heads on the later tillers, which may not be ripe. Harvesting with the sickle is faster, and the straw, as well as the rice heads, is gathered.

An important development in padi farm management is the increasing use of rice straw as bedding for cattle, resulting in a supply of high-quality manure. Rice straw is also picked over by the cattle and forms a useful supplement to their diet.

The use of the sickle is essential if padi straw is to be used in this way and the change from harvesting with the *tuai* to using the sickle is particularly marked on the east coast, where farmers are cooperating in erecting cattle sheds in which the padi straw can be utilised.

Rice harvested by the *tuai* is threshed by treading; the cut heads are laid on a mat or wooden floor, and the heads are trodden and worked round usually by women or young girls. Subsequently the padi is separated from the stalks by winnowing. Rice harvested by sickle is

threshed by beating it against wood. In the Federation the most common form of threshing device is the tub, essentially shaped like a half barrel with a small ladder inside it and with protective screens of mats on three sides. The sheaves of rice are brought to the threshing tub, and there beaten firmly until all the grain has fallen off. Threshing of rice harvested by *tuai* is usually done at the house site, but that harvested by sickle is threshed in the field.

After threshing and winnowing, the padi is dried. All padi in the Federation is sun dried. It is laid on mats or concrete floors in a thin layer during the day while the sun is shining, and occasionally turned, being brought in at evening, before dewfall. The drying goes on until the moisture content of the grain, which may have been as high as 20 per cent at harvest, depending on weather conditions, has been reduced to a safe level, about 14 per cent. When the moisture content has been brought down to a safe level, the padi is removed to storage.

Types of padi store vary greatly. Commercial stores are large buildings of concrete and wood or brick, but the bulk of locally produced rice is stored in village houses, for the consumption of the villagers. Village stores are generally of bamboo, wood and *mengkuang*, raised above the level of the ground to lessen the risk of flood damage and vermin proofed to a greater or lesser degree.

A considerable amount of work on the mechanical harvesting and threshing of rice in Malaya has been done, and investigations are still in progress. A combine harvester has been used with some success in north Malaya, and details reported. (*Malay agric. J.* 38 1955, pg 237.) Mechanical threshing with machines of various types has had some success, although the problem of grain shattering and fracture has not been fully overcome.

SOME EFFECTS OF SEEDLING AGE ON TRANSPLANTED RICE

BY

F. B. BROWN

Formerly Senior Botanist.

Introduction

The practice of raising rice seedlings in a nursery and transplanting to the rice field later is common to nearly all rice growing areas. In some places, such as the United States of America, where conditions are suitable for complete mechanisation, the seeds are sown directly into the fields by drilling or broadcasting.

It is recognised that yields from transplanted rice are greater than those from a drilled or broadcast crop and transplanting by hand is continued in some mainly mechanised areas, although in Italy the transplanting stage, too, is mechanised in a few small districts. The main advantages of transplanting are the saving in seed and the simplification of cultural practices, especially weeding, during the growing period of the plants. In regions with large farms and high agricultural wages the value of the loss in yield by not transplanting is more than offset by the saving in labour charges by mechanisation.

The age at which seedlings are transplanted varies from country to country and appears to be traditional rather than based on scientific experimentation. In Malaya, it was uncommon to transplant seedlings less than 40 days old; more often the age was 45—65 days or even more. In some countries where wet seed beds are used, a week in the nursery is allowed for every month's duration of the crop; where dry nurseries are employed seedlings are allowed to remain longer because of the comparatively slower growth.

Where 'age of transplanting' experiments have been reported the only character which has been considered has been yield. In one country where 30 days is considered as the optimum seedling age, decreases of yield of the order of 20 and 75 per cent were incurred by using seedlings 45 and 60 days old respectively. In the experiments reported in this paper the effect of different ages of seedlings on other characters in addition to yield is considered. These include maturation period, tiller production, plant height, ear length, ear weight, grain density, etc.

Method

Methods used are given with each experiment but except where otherwise stated, the following records were kept.

- (1) Dates of sowing and transplanting.
- (2) Date of 50 per cent flowering (in unselected varieties this is considered more satisfactory than date of first flowering).
- (3) Date of maturity.

- * (4) Number of tillers/plant (Average of 20 plants/plot).
- * (5) Plant height.
- (6) Ear length and weight.
- (7) Yield per acre measured by weight and volume.
- (8) Mean *gantang* † weight.
- (9) Assessment of damage due to climate, pest and disease.

Ten experiments are reported in this paper, as follows:

Expt. No.	Place	Layout	Plot Size	Variety	Season
P.110	Kendong	x 6 R.B.	1/80 acre	Serendah Kuning	1949/50
P.114	Ampang Tinggi	"	"	"	"
P.118	Ulu Klawang	"	"	"	"
P.149	Kendong	"	"	"	1950/52
P.153	Ampang Tinggi	"	"	"	"
P.158	Ulu Klawang	"	"	"	"
P.15	Langgar, Kedah	x 6 L.S.	1/330 acre	Not known	1943/44
P.28 (a)	Telok Chengai, Kedah	x 6 R.B.	1/120 acre	Haji	1947/48 1948/49 1949/50
(b)	"	"	"	Haroun	
(c)	"	"	"	Radin	
				China 4	
				Seraup	
				Kechil 48	

Trials in Negri Sembilan, First Series

KENDONG P.T.S.

EXPERIMENT NO. P. 110

This trial was carried out at Kendong P.T.S. (Padi Test Station) in 1949/50 and continued in its original form for only one season. There were five treatments using seedlings 40, 47, 54, 61 and 68 days old at transplanting. Seed for all treatments was sown on the same day, 28th June, and the different treatments were transplanted at weekly intervals. The variety used was unselected Serendah Kuning, the medium term variety (180 days) most commonly grown in this district. The layout used was a randomised block arrangement of 1/80 acre plots with six replicates.

All plots were in 50 per cent flower between 12th December and 2nd January and ripened between 24th and 31st January. Heavy rains occurred during the flowering phase with the result that approximately 50 per cent of the spikelets in all treatments were empty at maturity; there was no evidence of differential effect on the various treatments. A considerable amount of bird damage occurred prior to harvest and an estimate of the percentage of affected plants is included in the tabulated treatment means (Table I).

* Measurements of plant heights and tiller counts were taken between completion of flowering and harvesting.

† *gantang* = gallon.

Table I
Experiment P.110. Kendong P.T.S. 1949/50. Tabulated Treatment Means

Seedling age (days)	Days from		Tillers per plant	Plant height (in.)	Ear length (in.)	Ear weight (gm.)	Gantang weight (lb.)	Yield		Bird damage %
	Planting to 50% flowering	Sowing to maturity						Gantangs per acre	(lb.) per acre	
40	130.8	211.0	9.2	40.6	10.8	4.64	5.98	228.8	1368	123
47	125.2	211.0	10.0	41.2	10.3	4.84	5.95	238.1	1417	127
54	122.5	212.7	9.7	40.1	10.6	4.28	5.94	220.6	1310	118
61	121.0	215.7	8.9	39.0	10.8	3.99	5.87	142.4	936	75
68	115.3	216.7	8.2	39.1	10.9	4.48	5.89	106.5	627	56
Mean (G.M.)	122.8	213.4	9.2	40.0	10.7	4.35	5.93	187.3	1112	100
S.E. (20) †	.804	.346	.314	.426	.0962	.205	—	18.7	111	10
C.Ve. (%) ‡	1.6	4.0	8.33	2.6	2.2	11.6	—	24.5	—	—

* General mean.

† Standard Error of the mean with number of degrees of freedom given as a Suffix.

‡ Coefficient of variation of error.

There is a highly significant (one per cent probability) effect on maturation period. In the first place, as would be expected, the older the seedlings the shorter the interval between transplanting and 50 per cent flowering. This is not, however, fully compensatory as the older the seedlings the greater the interval from sowing to 50 per cent flowering, the 68 day seedlings reaching this stage some 13 days later than the 40 day seedlings. The same effect appears in a modified but still highly significant degree in the total maturation period—from sowing to ripeness—the older the seedlings the longer the maturation period, although panicles in the 40 day treatment took 40 days to ripen (from 50 per cent flowering) while those of the 68 day seedlings ripened in 34 days. Bird damage may have accelerated ripening, and as it was more severe on the 61 and 68 day treatments, the maturation periods of these should possibly have been still longer than the times recorded.

Other differences between treatment effects while statistically significant are less clearly defined. There appears to be a tendency for overaged seedlings to tiller less profusely and produce shorter plants than the younger seedlings. Seedlings from 40 to 54 days old gave a significantly higher tiller count than 68 days old seedlings. Plant height was significantly greater in the 40 and 47 day treatments than in the 61 and 68 day ones.

The effect of treatment on ear characters is obscured by the bird damage. The only significant difference in ear weight was that between the 40 and 61 day treatments but as these were respectively the least and the most damaged it is probable that there is no real treatment effect. There may be a tendency for the older seedlings to produce longer ears as ear length of the 47 day plants was significantly less than that of any other treatment and the 68 day treatment gave longer ears than the 54; the behaviour of the 40 day plants does not, however, conform.

The higher grain yield from the 47 to 54 day treatments as compared with the 61 and 68 day treatments is highly significant. This difference is undoubtedly due in part to the excessive bird damage suffered by the two latter treatments. Bird damage was assessed as the percentage of plants in each plot which suffered damage in some degree and the actual loss of crop was less than the percentage damage recorded, probably not more than 15 per cent in the 61 and 68 day treatments. There is a progressive reduction of yield from that of the 47 day treatment as older seedlings are used and the reduction in crop between the 47 and 68 day treatment is over 50 per cent. There is little doubt that the use of seedlings older than 50 days at transplanting is likely to have a serious effect on yield.

EXPERIMENT NO. P. 114

This trial was carried out at Ampang Tinggi P.T.S. for one season in 1949/50. There were four treatments using 44, 51, 58 and 65 day old seedlings, all of which were sown on the same day, 26th March, 1949, an abnormally early date for sowing a photosensitive

variety. The variety used was again unselected Serendah Kuning. Again a randomised block layout with six replicates was used, the plot size in this experiment, however, being 1/120 acre.

All plots were in 50 per cent flower at about the same time, between 30th November and 5th December, and ripened between the 8th and 13th of December. A heavy infection by *Cercospora oryzae* occurred shortly before flowering but affected all treatments similarly and did not have a serious effect on growth or yield. The experiment was flooded by river encroachment on several occasions, resulting in a high proportion of lodged plants at harvest, which is exceptional with this, a strong strawed variety. The 44 day treatment was least affected as is shown in Table II.

With one exception, ear length, there are no significant effects of treatments on any of the characters measured. Ears from the 65 day treatment were significantly longer than those of the 44 day treatment, the two intermediate falling in logical order, the 58 day treatment having very slightly longer ears than the 51 day treatment, though this does not appear in the tabulated figures, which have been rounded off. While there are no significant differences in plant height the trend suggests a tendency for the overaged seedlings to give taller plants, a behaviour contrary to that in Experiment No. 110.

No final conclusions can be drawn in regard to the effect of treatments on yield but it is noteworthy that the 68 day treatment gave a yield some 13 per cent less than that of the younger seedlings. Error variance was very high and it is likely that with better error control this difference would have approached significance.

It is possible that the abnormally long maturation periods which resulted from the very early sowing of this experiment may have obscured treatment effects to some extent.

ULU KLAUANG P.T.S.

EXPERIMENT No. P.118

This trial was similar in all respects to the foregoing one (P.114) except that the four treatments consisted of 40, 47, 54 and 61 day old seedlings, plots were 1/160 acre in size and sowing was carried out on 7th April, 1949, still too early for this variety.

All plots were 50 per cent in flower between 20th October and 6th November and ripened between 16th November and 1st January, 1950. No outbreak of disease occurred but all plots of three treatments were slightly affected by stem borer (1 to 2 per cent of plants attacked), the 61 day treatment being the one uninfested. As in the two previous experiments yields were recorded by volume, in *gantangs* (gallons), from which the weights given in the table have been calculated. (See Table III.).

Treatments have had no significant effect on tillering, height, ear weight, or plot yield. There is a tendency for the older seedlings to

Table II
Experiment P.114. Ampang Tinggi P.T.S. 1949/50. Treatment Means.

Seedling age (days)	Days from		Tillers per plant	Plant height (in.)	Ear length (in.)	Ear weight (gm.)	Gantang weight (lb.)	Yield			Lodging %
	Planting to 50% flowering	Sowing to maturity						Gantangs per acre	lb. per acre	% G.M.	
44	176.7	260.5	10.8	46.3	9.9	4.32	5.30	436.0	2312	102	34
51	169.2	259.7	10.7	46.3	10.1	4.97	5.39	452.4	2438	107	59
58	163.0	260.5	11.7	46.6	10.1	4.57	5.41	426.0	2305	102	49
65	154.8	259.2	11.3	48.1	10.2	4.84	5.37	376.0	2019	89	57
G.M.	165.9	260.0	11.1	46.8	10.1	4.67	5.37	422.6	2268	100	—
S.E. (15)	—	.683	.289	.654	.0998	.292	.0409	58.1	312	14	—
C.Ve (%)	—	0.6	6.4	3.4	4.6	15.3	1.9	33.7	—	—	—

Table III
Experiment P.118. Ulu Klawang P.T.S. 1949/50. Treatment Means.

Seedling age (days)	Days from		Tillers per plant	Plant height (in.)	Ear length (in.)	Ear weight (gm.)	Gantang weight (lb.)	Yield		
	Planting to 50% flowering	Sowing to maturity						Gantangs per acre	lb. per acre	% G.M.
40	152.5	228.7	7.5	38.3	9.9	5.17	5.61	318.4	1786	108
47	158.0	228.5	7.2	37.4	9.9	4.97	5.62	306.4	1722	104
54	151.0	232.8	7.6	37.7	10.1	4.89	5.59	274.9	1537	93
61	143.0	230.2	6.9	37.9	10.3	5.24	5.57	282.4	1573	95
G.M.	151.1	230.0	7.3	37.8	10.0	5.07	5.60	295.5	1655	100
S.E. (15)	—	1.24	.245	.322	.0834	.124	.0323	21.4	120	7.25
C.V. (%)	—	1.3	8.2	2.1	2.0	6.0	1.4	17.5	—	—

have a longer maturation period, the 54 day treatment though not the 61 day, having a significantly though only slightly longer maturation period than the 40 and 47 day plants. Unlike P.110, there is no evidence of accelerated ripening of any treatment in either this or the preceding experiment, P.114.

Ear length in the 61 day treatment is significantly greater than in the 40 and 47 day plants. While differences between yields do not reach significant level, it is noteworthy that they fall as seedling age increases and the 40 day treatment gave over 13 per cent more crop than that from the older seedlings. That the 61 day treatment gave a slightly higher yield than the 54 day may be related to the fact that the former was the only treatment unaffected by stem borer.

Trials in Negri Sembilan, Second Series

In 1950 the experiments at the three stations in Negri Sembilan were reorganised so that the design and treatments used at the three stations was the same, making, in fact, a single experiment replicated at three different stations. The layout was that previously used at Kendong, six randomised blocks of 1/80 acre plots. A sixth treatment was included to cover seedlings 35, 40, 47, 54, 61 and 68 days old at transplanting. At all stations the variety used was again unselected Serendah Kuning indigenous to each locality. This experiment was continued for two years, until the completion of the 1952 season. The layout was rerandomised at each station in the second year. In the second year too, sowing of each treatment was successive so that transplanting of all treatments was simultaneous, a refinement intended to minimise the effects of possible variation in conditions in the field in the first few weeks after transplanting. Yields were recorded directly by both volume and weight. In the first place, these experiments will be considered individually.

KENDONG P.T.S.

EXPERIMENT NO. P.149 (NS.13)

In 1950 all treatments were sown on 16th May and were 50 per cent in flower between 12th November and 3rd December and all plots ripened between 20th December and 16th January, 1951, the older seedlings flowering and maturing latest. But for a localised outbreak of *Leptocorisa acuta* in some of the later flowering plots no damage from pest, disease or weather occurred, the only mishap being that, owing to temporary labour shortage, transplanting the 61 day seedlings was delayed for six days and were therefore 67 days old when planted. (Table IV).

Effects on maturation period are highly significant, the 35 and 40 day treatments having a significantly shorter and the 61 and 68 day treatments a significantly longer maturation period than any other treatments. As in P.110, the youngest seedlings were in 50 per cent

Table IV

Experiment P.149. Kendong P.T.S. 1950/51. Treatment Means.

Seedling age (days)	Days from		Tillers per plant	Plant height (in.)	Ear length (in.)	Ear weight (gm.)	Gantang weight (lb.)	Yield		
	Planting to 50% flowering	Sowing to maturity						Gantangs per acre	lb. per acre	% G.M.
35	148.2	218.5	10.2	45.7	10.6	5.16	5.94	336.5	1933	138
40	143.7	219.7	10.3	45.7	10.4	4.58	5.94	304.8	1720	123
47	137.5	228.5	10.7	46.1	10.6	4.53	5.97	291.6	1660	119
54	133.2	230.7	9.4	41.7	10.7	4.20	5.92	238.0	1210	86
(61)	131.7	244.0	7.6	40.2	10.3	2.35	5.82	168.0	967	69
68	131.3	245.0	8.4	39.1	10.6	3.34	5.79	154.8	900	64
G.M.	137.6	231.0	9.4	43.1	10.5	4.03	5.89	243.9	1398	100
S.E. (25)	.681	.637	.526	.819	.159	.196	.0339	15.0	88.3	6.32
C.Ve (%)	1.21	0.7	25.7	4.7	3.7	11.9	1.4	14.7	15.5	—

flower two weeks before the 68 day seedlings, but unlike that experiment, however, in this case the older the seedlings the longer the period from flowering to maturity. It is probable that the latter interval is determined more by climatic conditions than by treatments.

Other significant effects noted in previous experiments which are again apparent in this are reduction of tillering and plant height by increasing seedling age, the 35, 40 and 47 day seedlings all producing significantly more tillers and taller plants than the 61 and 68 day seedlings.

There are no significant differences in ear length, but there are highly significant differences in ear weight. Ears from the 35 day treatment were significantly heavier than any others and the 40, 47 and 54 day treatments gave significantly heavier ears than the 61 and 68 day plants. The abnormally light weight of the 61 day ears cannot be readily explained, particularly as the grain density (*gantang* weight) was normal; the original data suggests that there may have been an error in weighing ear samples from two of the plots as the weights recorded are precisely 100 gm. less than weights estimated for those plots. On the other hand the ear samples from these two plots may have coincided with a patch of plants affected by *Leptocorisa*. The younger seedlings have given significantly denser grain (higher *gantang* weight) than the oldest seedlings, though there is no difference between the 35 to 54 day treatments. While this was not demonstrated in the previous experiments, reference to Tables I and III shows that the same tendency occurs there.

The 35, 40 and 47 day treatments outyielded the 54 to 68 day ones highly significantly and the 35 day plants gave a significantly higher yield than the 47 day ones. A loss of 50 per cent of the crop resulted from extending seedling age from 35 to 68 days, being over 50 per cent. Even the 47 day seedlings, an age at which transplanting is frequently practised, resulted in a loss in yield of over 13 per cent, as compared with the 35 day treatment.

In the second season, 1951/2, this experiment was less successful. Sowing commenced on 9th April, over one month earlier than in the previous season and resulted in abnormally long maturation periods. All treatments suffered considerable damage from wind and rain during and after flowering which resulted in a poor set of seed. All treatments were transplanted on 16th June, were in 50 per cent flower between 20th and 30th of November and ripened between 6th and 16th January.

The system, introduced this season, of consecutive sowings and simultaneous transplanting, effectively shortened the duration of flowering and ripening; on the other hand it may have introduced differential photosensitivity effects confounded with treatments; but as sowing was completed within 34 days, this should not have increased the maturation period of the 68 day treatment by more than 10 days relative to the 35 day treatment (Table V).

Table V

Experiment P.149. Kendong P.T.S. 1951/52. Treatment Means.

Seedling age (days)	Days from		Tillers per plant	Plant height (in.)	Ear length (in.)	Ear weight (gm.)	<i>Gantang</i> weight (lb.)	Yield			Wind and rain damage % stand
	Planting to 50% flowering	Sowing to maturity						<i>Gantangs</i> per acre	lb. per acre	G.M. %	
35	163.7	244.8	7.7	45.4	10.4	Not recorded	5.87	169.9	1050	113	22
40	163.3	249.8	7.4	46.0	10.7		5.83	140.8	835	90	36
47	161.7	257.2	7.8	46.4	10.2		5.94	133.3	843	91	27
54	158.0	263.8	7.3	46.7	10.6		5.82	164.7	972	105	23
61	158.8	270.7	7.3	45.4	10.4		5.90	165.7	998	107	27
68	159.0	276.7	7.8	45.3	10.3		5.89	148.1	875	94	22
G.M.	160.7	260.5	7.6	45.9	10.4		5.88	154.6	929	100	—
S.E. (25)	2.76	.589	.255	.632	.114		.0389	13.3	75.7	8.15	—
C.V. (%)	1.4	0.5	8.3	3.4	2.7		1.6	21.1	20.0	—	—

The only clear effect is the progressive and highly significant increase in maturation period as seedling age increased. Judging from other experiments on the relation of maturation period to time of sowing, not more than a third of the increase can be attributed to the system of successive sowings used. No significant differences appear in tillering, height or yield and the few differences in ear length and grain density which occur do not lead to any logical conclusion. It is possible that treatment effects are masked by the damage resulting from adverse weather and also, as in the case of P.114, by the abnormally long maturation period resulting from early sowing.

AMPANG TINGGI P.T.S.

EXPERIMENT No. P.153 (N.S. 14)

In 1950 all treatments were sown on the same day as at Kendong, 16th May, and were 50 per cent in flower between 10th and 26th November, and ripened between 16th and 31st December, the older seedlings flowering and ripening towards the end of these periods. A slight outbreak of *Helminthosporium oryzae* occurred in the nursery and affected the older seedlings most. Apparently complete recovery occurred after transplanting and no subsequent effect was observed. The experiment was flooded on 7th December when flowering was completed and though, as a result, many plants in eleven of the plots lodged, the loss of crop was not appreciable and treatments were not affected differentially. The yield from this crop was in fact satisfactorily high. (Table VI).

The shorter maturation period of the 35 day treatment and the longer period of the 61 and 68 day seedlings is again highly significant. There is no evidence of treatment effect on rate of ripening of grain. Nor is there any significant effect on height of plant, ear length or ear weight. While there are significant differences in tillering and grain density there appears to be no straightforward explanation why the 40 day seedlings should have produced more tillers than the 54 and 35 day treatments or why the latter should have given denser grain than the 61 day seedlings.

As regards yield, differences are not precise, the only significant one being that between the 35 and 54 day treatments; nevertheless the three younger seedlings appreciably, if not significantly, outyielded the older seedlings.

In the second season, 1951/52, conditions were unsatisfactory. Owing to there being much unplanted land in the vicinity of the station, above five per cent of the crop was lost to birds, all treatments being similarly affected, and from 40 to 60 per cent of plants of different treatments were seriously damaged by rats. Yields were, therefore, abnormally low.

Sowing commenced on 3rd April and was completed on 6th May; transplanting was carried out on 10th June. All treatments were

Table VI

Experiment P.153. Ampang Tinggi P.T.S. 1950/51. Treatment Means.

Seedling age (days)	Days from		Tillers per plant	Plant height (in.)	Ear length (in.)	Ear weight (gm.)	Gantang weight (lb.)	Yield		
	Planting to 50% flowering	Sowing to maturity						Gantangs per acre	lb. per acre	% G.M.
35	144.0	215.5	11.3	47.7	10.1	5.18	5.41	70.08	3874	109
40	142.7	219.0	13.2	49.9	10.2	5.08	5.31	670.6	3674	103
47	136.2	219.3	12.9	48.9	9.9	4.80	5.36	672.4	3760	105
54	129.2	219.2	11.6	47.6	10.0	4.61	5.35	580.8	3236	91
61	131.8	226.0	12.1	47.7	9.7	4.51	5.30	628.9	3480	97
68	125.0	227.2	11.5	48.2	9.9	4.82	5.33	613.9	3392	95
G.M.	134.8	221.0	12.1	48.3	10.0	4.83	5.34	644.6	3569	100
S.E. (25)	.693	.769	.486	.955	.185	.273	.0345	34.9	204	5.72
C.V. (%)	1.3	0.8	9.8	4.8	4.5	13.8	1.6	13.3	14.0	—

in 50 per cent flower simultaneously between 13th and 26th November and matured between 17th December and the end of that month. No records of ear length and ear weight were made. (Table VII).

The increase of maturation period with increasing seedling age is again highly significant in respect of all treatment comparison. No significant differences in tillering or plant height are shown but the three younger seedlings again tend to give more tillers and taller plants than the older seedlings. Plot yield was often too small to provide a sufficient grain sample for accurate estimation of *gantang* weight, the analysis of which is therefore omitted.

With the exception of the 35 day treatment, yields appear to be directly related to the amount of rat damage; the 35 day seedlings did outyield all others except the 47 day treatment. The 40 day treatment was only outyielded, however, as it was more heavily attacked by rats; covariance analysis of yield and rat damage results in adjusted means of 640 lb., 472 lb., and 491 lb. per acre, for the 35, 40 and 47 day treatments respectively, and these do not differ significantly, M.S.D. (5%) being 168 lb.

ULU KLawang P.T.S.

EXPERIMENT No. P.158 (N.S. 15)

Sowing seed for this experiment was carried out very early, on 25th March, the different treatments being transplanted on the appropriate dates. All treatments flowered between 14th and 28th October and all but two plots had ripened by the end of November. Shortly after transplanting, flood washed out two plots of the 68 day treatment and these are treated as 'missing plots' in the analysis of the results. A slight attack by stem borer occurred but infestation was not more than four per cent of the population except for the 47 day treatment in which 13 per cent infestation occurred. Otherwise conditions were satisfactory and the crop good for this station. (Table VIII).

As usual, increasing seedling age increases maturation period, though in this experiment there is no significant difference between the 54 and 61 or 61 and 68 day treatments. Differences in vegetative growth appear to be anomalous and offer no logical explanation. The 61 day treatment produced a higher number of tillers than the 40 to 54 day plants, there being no significant differences between other treatments. The 47 day treatment produced the tallest plant but otherwise the plant heights are in logical order, the 68 day plants being significantly shorter than all but the 61 day ones.

While there are significant differences in ear length these again appear to be irregular. As regards ear weight the older seedlings as a group conform to behaviour in previous trials and produce lighter ears. There are no differences in density of grain from the various treatments nor do the yields show any regular differences or trends. The only

Table VII
Experiment P.153. Ampang Tinggi P.T.S. 1951/52. Treatment Means.

Seedling age (days)	Days from		Tillers per plant	Plant height (in.)	Gantang weight (lb.)	Yield			Rat dage (% plants)
	Planting to flowering	Sowing to maturity				Gantangs per acre	lb. per acre	% G.M.	
35	166.2	234.0	8.5	43.3	5.29	125.9	668	137	46
40	164.7	238.0	8.5	43.3	5.28	78.7	423	87	62
47	163.3	243.0	8.4	43.1	5.30	101.6	537	110	42
54	165.7	248.7	8.2	42.3	5.25	77.5	415	85	59
61	161.3	255.0	8.2	42.9	5.25	85.9	453	93	50
68	159.3	260.5	8.0	42.8	5.27	78.4	421	87	58
G.M.	163.4	246.5	8.3	43.0	5.27 *	91.3	486	100	—
S.E. (25)	1.62	.935	.222	.456	—	11.8	63.7	13.1	—
C.Ve. (%)	2.4	0.9	6.5	2.6	—	31.8	32.1	—	—

* Data incomplete

Table VIII

Experiment P. 158. Ulu Klawang P.T.S. 1950/51. Treatment Means.

Seedling age (days)	Days from		Tillers per plant	Plant height (in.)	Ear length (in.)	Ear weight (gm.)	Gantang weight lb.	Gantang			Stem Borer (% Plants)
	Planting to 50% flowering	Sowing to maturity						per acre	lb. per acre	% G.M.	
35	169.0	231.0	8.8	40.6	10.8	6.17	5.63	338.2	1935	93	4
40	167.3	233.2	8.1	40.4	10.3	5.59	5.66	400.8	2234	108	3
47	157.7	231.0	8.4	43.5	10.8	6.23	5.61	422.4	2269	109	13
54	152.5	242.8	8.3	39.1	10.4	5.10	5.59	359.1	2021	97	1
61	148.0	242.2	9.8	38.7	10.6	4.97	5.62	369.1	2110	102	3
68	144.5	240.7	9.2	36.6	10.3	5.21	5.62	320.0	1869	90	3
G.M.	156.5	236.8	8.8	39.8	10.5	5.55	5.62	368.2	2073	100	—
S.E. (23)	1.67	1.96	.392	.777	.153	.264	.0228	28.2	177	8.54	—
C.Ve (%)	2.61	2.0	11.0	4.8	3.6	11.6	1.0	18.8	20.9	—	—

Table IX
Experiment P.158. Ulu Klawang P.T.S. 1951/52. Treatment Means.

Seedling age (days)	Days from		Tillers per plant	Plant height (in.)	Gantang weight (lb.)	Yield	
	Planting to 50% flowering	Sowing to maturity				Gantangs per acre	lb. per acre
35	166.7	227.3	7.7	37.0	5.65	331.6	1853
40	164.2	231.3	7.6	36.5	5.65	292.0	1647
47	162.5	235.5	6.8	36.2	5.61	249.1	1433
54	165.0	245.3	7.5	36.1	5.65	298.9	1740
61	165.8	249.8	8.0	36.0	5.63	300.9	1700
68	165.5	259.2	7.4	35.9	5.60	310.0	1747
G.M.	164.9	241.4	7.5	36.3	5.63	297.1	1687
S.E. (25)	1.77	1.65	.351	.599	.0323	30.2	178
C.Ve (%)	2.6	1.7	11.4	4.0	1.4	24.9	26.0
							—

differences being that the 47 day, the highest yielding treatment, out-yielded the 35 and 68 day plants.

It may be that the anomalies resulting in this trial were due to excessive soil variation within blocks. *Petak₂* (fields) at this station are small and in several cases blocks had to be split between two different *petak*.

In the second season, 1951/52, sowing was commenced on 17th March and completed on 19th April. All treatments were transplanted on 24th May, and were in 50 per cent flower between 24th October and 14th November, and all but two plots ripened between 28th November and 8th December. Very slight rat attack occurred in four plots of different treatments but the damage done was insignificant; no other pests or diseases were recorded. Ear lengths and weights were not recorded. (Table IX).

Differences in maturation period are again highly significant, the 68 day treatment being significantly the longest and the 61 and 54 both longer than the remaining treatments in maturing. The 47 did not differ from the 40 day treatment but took longer than the 35 day plants. There were no logical differences in tillering, the 61 day plants producing more than the 47 day plants. While there are no significant differences in plant height the tendency for the younger seedlings to produce taller plants is again apparent. There is a similar tendency for the overaged seedlings to produce lighter grain. There were no differences in yield.

Yield Analyses, Negri Sembilan

Yield being the factor of greatest importance, a combined analysis of the yield records of the last six trials was carried out. (Table X).

Table X

Analysis of yields at the three Negri Sembilan Stations in the two seasons 1950/51 and 1951/52.

Station	Seedling age in days	Mean Yield in lb. per acre						Mean
		35	40	47	54	61	68	
Kendong	-	1492	1278	1252	1091	983	888	1164
Ampang Tinggi	-	2272	2049	2149	1826	1967	1907	2028
Ulu Klawang	-	1875	1942	1852	1881	1906	1809	1881
Mean 1950/1	-	2581	2542	2562	2155	2185	2053	2346
„ 1951/2	-	1190	968	937	1042	1051	1014	1034
Treatment Mean	-	1886	1755	1750	1598	1618	1534	1690
Percentage	-	100	93	93	85	86	81	

Table XI
Effect of Increasing Seedling Age, Negri Sembilan

Experiment No.		110	114	118	149(1)	(2)	153(1)	(2)	158(1)	(2)
Character										
Ripening period	...	(-)	0	0	(+)	0	0	0	0	0
Maturation period	...	@	0	0	@	@	@	@	+	@
Number of tillers	...	-	0	(-)	-	0	(-)	(-)	(+)	0
Plant height	...	-	(+)	0	-	0	0	(-)	-	(-)
Ear length	...	+	+	+	0	0	0	N.R.	0	N.R.
Ear weight	...	0	0	0	=	N.R.	(-)	N.R.	-	N.R.
Gantang weight	...	(-)	0	(-)	-	0	-	(-)	0	(-)
Yield	...	=	(-)	(-)	=	0	-	(-)	0	0

Key to symbols:—

-	Significant (5%) negative effect.	=	Highly significant (1%) negative effect.
+	Significant (5%) positive effect.	@	Highly significant (1%) positive effect.
()	Trend, but not statistically significant.	N.R.	Not recorded.
0	No significant difference or apparent trend.		

Variances for effects of seasons, stations and treatments and season/treatment interaction are all significant as compared with error variance at the one per cent point; seasons and station variances are likewise significant against their corresponding treatment interactions. Treatment variance is significant against treatment/station interaction at the five per cent point but is not significant against treatment/season interaction. Station/treatment interaction not being significant it may be taken that treatment effects were generally similar at all stations. Treatment variances being of a similar order to treatment/season interaction ($V.R. * = 1.05$) the two effects cannot be dissociated.

The minimum significant difference (M.S.D.) for treatment means is 162 lb. per acre. The 35 day seedlings therefore gave a significantly higher yield than the 54 day seedlings by 288 lb./acre and the 40 and 47 day seedlings outyielded the 68 day ones by some 215 lb. per acre. M.S.D. for stations was 115 lb. and for seasons 94 lb. per acre.

A more precise estimation of treatment effect may be obtained by eliminating the three experiments most severely damaged by pest and weather and reanalysing the three relatively undamaged experiments, viz., Kendong and Ampang Tinggi, 1951/52 and Ulu Klawang, 1950/51. Treatment means are then as follows:

Age of seedling	35	40	47	54	61	68	G.M.
Lb. per acre	2554	2346	2284	2062	2049	2013	= 2218
Per cent (Fig. 1)	100	92	89	81	80	79	

M.S.D. (5%) in 267 lb. per acre (12% of G.M.), and the 35 day treatment has outyielded the 47 day, the 40 outyielded the 54 and the 47 outyielded the 68 day treatment by amounts of over 12 per cent of the overall mean yield.

Joint statistical analyses of effects other than yield have not been carried out but the indications of the nine trials discussed above have been schematically summarised in Table XI.

From the foregoing summary it is concluded that increasing seedling age increases maturation period and decreases tillering, plant height, ear weight and grain yield and density. There is probably no effect on rapidity of ripening and the increased ear length in the first three experiments requires confirmation.

Yields fall off most rapidly as age of seedling increases from 35 to 54 days, on an average the loss of crop being one per cent for each additional day of seedling age. After 54 days the curve flattens and further loss is more gradual. (Fig. 1).

Trials in Kedah

LANGGAR P.T.S.

EXPERIMENT No. P.15

This experiment was carried out in the 1943/44 season and the only complete data which have survived are those for plot yields of

* V.R. = Variance ratio.

Fig. 1

TRIALS IN NEGRI SEMBILAN

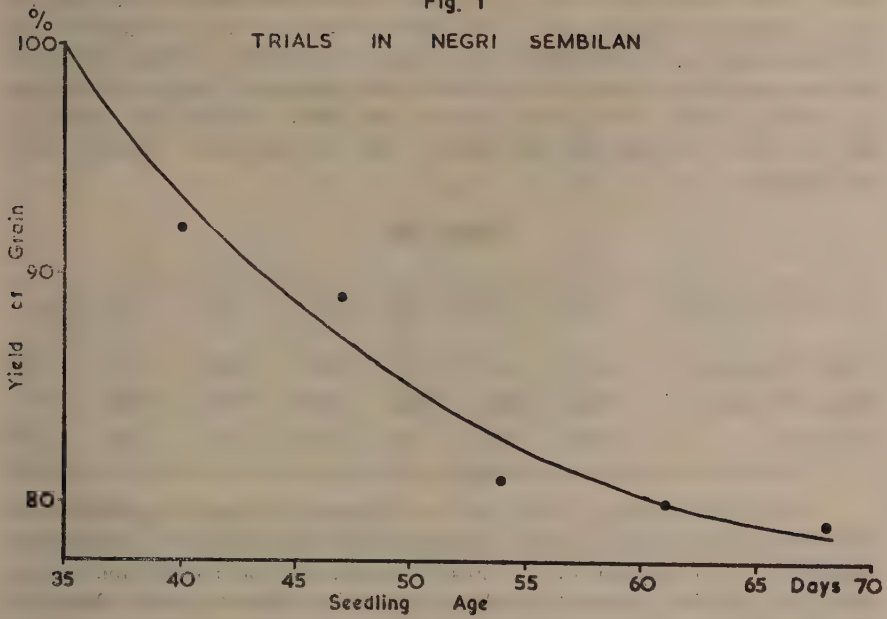
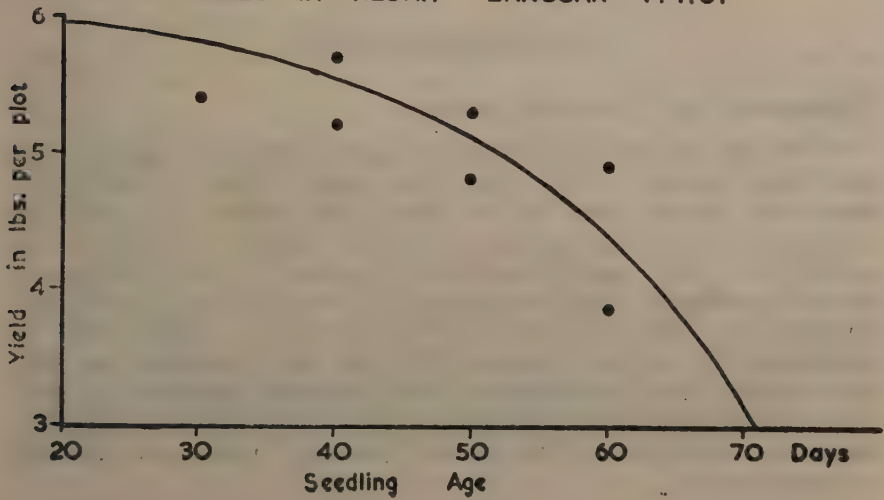


Fig. 2

TRIALS IN KEDAH - LANGGAR P.T.S.



grain. The layout was a 6 x 6 Latin Square with plots 12 ft. square or approximately 1/330 acre. The variety used is not now known but at this station was undoubtedly a medium term variety of approximately 180 day growing period and probably either Mayang Ebos, Radin China or Subang Intan. The Mean Square for error was 0.1548 giving a M.S.D. (5%) of 0.475 lb. per plot or 157 lb. per acre. Results were as follows:—

Table XII

Age of Seedling, days	20	30	40	50	60	70	S.E.
Yield, lb./plot	5.39	5.05	5.22	5.01	4.78	3.74	.161
Yield, lb./acre	1781	1669	1725	1656	1580	1236	53.1
Per cent	100	94	97	93	89	69	2.98

While the fall in yield does not attain statistical significance in this experiment until seedlings are some 54 days old, it is noteworthy that, with the exception of the 30 day treatment, yield reduction is progressive and the youngest seedlings gave the highest yield. After 55 days of age the fall in yield becomes very rapid. (Figure 2).

The rate of change of treatment effect in this experiment, unlike those conducted in Negri Sembilan, increased with seedling age and it is evident that the regression curve will differ in form with different environments or cultural conditions. As sowing does not commence at Langgar before June and harvest is normally in December/January when conditions become very dry, it is probable that the plants from the older seedlings were forced to premature ripeness by weather conditions.

TELOK CHENGAI P.E.S.

EXPERIMENT No. P.28 (K/P. 3A-C)

In this trial three varieties of varying maturation periods were used; Haji Haroun = H.H. (150 days), Radin China 4 = R.C.4 (180 days) and Seraup Kechil 48 = S.K.48 (210 days). The trial was commenced in 1947 and continued for three consecutive seasons to the end of 1950. Each variety was tested in separate 4 x 4 Latin Squares, the four treatments using seedlings 30, 45, 60 and 75 days old at transplanting; plot size was 1/120 acre (11 x 33 ft.). Trials were re-randomised in successive seasons. Seed for all treatments was sown simultaneously and transplantings were successive according to treatment. Only essential data were recorded in the first year but fuller records are available for the last two seasons. Yields were recorded by weight in lb.

K/P. 3A.—Haji Haroun

(a) Season 1947/48

Table XIII

Seedling age (days)	Maturation period	Tillers per plant	Yield		
			lb./acre	% G.M.	
30	140	9.5	885	112	Extensive damage by rats and birds.
45	147	7.5	990	126	Slight damage by birds.
60	154	6.2	889	113	Extensive rat damage.
75	160	4.2	383	49	No damage.
G.M.	150	6.9	787	100	
S.E. (6)	—	.204	90.7	11.5	
C.Ve (%)	—	5.9	17.7	—	

There is a progressive increase in maturation period with increasing seedling age conforming very closely to the relation of one day to two days respectively. Pests affected the various treatments differentially, the 30 day treatment being most severely damaged. Nevertheless, the efficiency of tillering is in inverse order to seedling age, the poorest being the oldest seedlings which were least damaged by pests. Relative yields of the 30 to 60 day treatments were upset by pest damage and all that can be safely concluded from this trial is that the oldest, 75 day seedlings gave significantly the poorest yield.

(b) Season 1948/49

In the second season seed of this variety was sown on 3rd August and transplanting was carried out between 2nd September and 17th October according to treatment. The treatments were in 50 per cent flower on 5th, 10th, 18th and 26th November and matured on 11th (30 and 45 day), 16th and 26th December, the treatments flowering in ascending order of seedling age. Slight rat and bird damage occurred in one plot of the 60 day treatment but did not affect yield, etc., appreciably. (Table XIV).

There is a progressive increase in the period from sowing to flowering with increasing seedling age and also in the total maturation period, except there is no difference between the 30 and 45 day treatments. Grain of the 30 day treatment appears however to have taken four to five days longer to ripen than normal. The maturation period increment is again approximately one day for each two days increase in seedling age. The oldest seedlings gave a significantly poorer tiller count

Table XIV
 Experiment P.28. Telok Chengai P.E.S. 1948/49. Treatment Means.

Seedling age (days)	Days from		Tillers per plant	Plant height (in.)	Ear length (in.)	Ear weight (gm.)	<i>Gantang</i> weight (lb.)	Yield	
	Planting to 50% flowering	Sowing to maturity						lb. per acre	% G.M.
30	64	130	11.9	46.5	9.3	4.06	5.72	2950	140
45	54	130	11.0	42.7	8.9	3.65	5.75	2806	133
60	47	135	12.0	35.9	8.2	2.40	5.58	1760	83
75	50	145	8.1	30.0	7.8	2.37	5.61	907	43
G.M.	51	135	10.7	38.8	8.52	3.12	5.67	2106	100
S.E. (6)	—	—	507	.872	.162	.184	.0247	142	6.74
C.Ve (%)	—	—	9.4	4.5	3.8	11.8	0.87	13.5	—

than the other three treatments, which did not differ. All treatments produced plants differing significantly in height, the older the seedlings the shorter the plants. Ear weight, length and grain density were significantly less in the 65 and 70 day treatments than in the 30 and 45 day ones. Grain yield diminishes progressively with increasing seedling age; while the 30 and 45 day treatments did not differ statistically, the 60 day plants gave significantly lower yield by some 40 per cent, and the 75 day plants were significantly the worst giving only 30 per cent of the yield of the 35 day plants.

(c) Season 1949/50

In the final season sowing took place on 7th July and transplanting between 5th August and 19th September. Treatments were in 50 per cent flower in the order of planting on 22nd and 24th October and 5th and 14th of November. Harvests were on 27th and 29th November and 8th and 13th December respectively. Field records state that no damage occurred but it is believed that the whole experiment lodged and yields were consequently low. (Table XV).

Again, increasing seedling age produced significant differences between all treatments in maturation period, plant height and yield. The 75 day seedlings produced significantly fewer tillers than the 45 and 60 day ones; the younger seedlings gave longer ears than the two older treatments. In this trial the only difference in ear weight is shown by the lighter ears from the 60 day treatment. Reduction of grain density with increasing age of seedling is progressive and significant. The dry conditions which prevail in this area at harvest and the fact that the older seedlings flowered later may account for the increase in rate of ripening with seedling age, which in turn probably accounts, at least to some extent, for the lighter grain from the older seedlings. On the other hand no such increase in rate of ripening occurred in the Radin China experiment which matured immediately after this one.

K/P. 3B—Radin China 4

(a) Season 1947/48

This variety was treated in the same way as Haji Haroun but being of longer maturation period flowered simultaneously with the main crop and suffered no pest damage. Yields were very good. (Table XVI).

Again, with increasing seedling age maturation period increased, in this case in the ratio of 3 : 1. The youngest seedlings tillered best and the 45 day seedlings produced significantly more tillers than the 60 and 75 day ones. While the 30 day treatment gave the highest yield, this did not differ significantly from that of the 45 day plants: both however outyielded the 60 day plants, which in turn outyielded the oldest seedlings.

Table XV
Experiment P.28. Telok Chengai P.E.S. 1949/50. Treatment Means.

Seedling age (days)	Days from		Tillers per plant	Plant height (in.)	Ear length (in.)	Ear weight (gm.)	Gantang weight (lb.)	Yield	
	Planting to 50% flowering	Sowing to maturity						lb. per acre	% G.M.
30	77	143	9.7	50.6	10.8	3.94	5.47	1744	142
45	65	145	10.7	47.8	10.7	3.92	5.34	1245	101
60	62	154	10.8	42.9	9.7	2.87	5.28	1016	82
75	56	159	8.1	37.8	9.7	3.37	5.25	926	75
G.M.	65	150	9.8	44.8	10.2	3.52	5.33	1232	100
S.E. (6)	—	—	.688	.754	.104	.189	.0150	23.3	1.89
C.Ve (%)	—	—	14.0	3.4	2.0	10.7	0.6	3.8	—

Table XVI

Experiment K/P 3B. Telok Chengai P.E.S. 1947/48.

Maturation Period and Tillering Means.

Seedlings age (days)	Maturation period	Tillers per Plant	Yield	
			lb. per acre	% G.M.
30	165	15.0	4189	122
45	175	13.5	4039	118
60	185	11.0	3248	95
75	195	10.0	2201	64
G.M.	180	12.4	3419	100
S.E. (6)	—	.382	149	4.36
C.Ve. (%)	—	6.2	8.7	—

(b) Season 1948/49

In this season sowing was carried out on 24th July and transplanting from 28th August to 7th October according to treatment. The various treatments were in 50 per cent flower on 10th, 15th, 20th and 23rd December and matured on 5th, 10th, 15th and 20th January respectively. None of the plots suffered damage from disease or pest. (Table XVII).

As in all other experiments in this series all replicates of any one treatment ripened within 24 hours and error variance was virtually nil; differences in maturation period of two or more days are therefore regarded as significant. In this case, three days increase in seedling age is associated with an increase in maturation period of one day. Differences in tillering are not significant. The 30 day seedlings produced significantly taller plants with longer and heavier ears than other treatments which did not differ except in that 75 day plants were significantly shorter. Grain density falls with increasing seedling age, though in this case there is no difference in rapidity of ripening of the grain between different treatments. The 30 day plants outyielded all others by a wide margin and the 45 day plants outyielded the 75 day ones.

(c) Season 1949/50

Sowing was done on 2nd June and transplanting between 1st July and 15th August. Treatments were in 50 per cent flower on 23rd, 24th, 27th and 29th November and ripened on 27th December, 1st and 6th January (60 and 75 days) respectively. No damage from disease or pest, etc. occurred. (Table XVIII).

Table XVII
 Experiment K/P 3B. Telok Chengai P.E.S. 1947/48. Treatment Means.

Seedling age (days)	Days from		Tillers per plant	Plant height (in.)	Ear length (in.)	Ear weight (gm.)	<i>Gantang</i> weight (lb.)	Yield	
	Planting to 50% flowering	Sowing to maturity						lb. per acre	% G.M.
30	109	165	11.8	45.2	10.8	4.40	5.91	3971	127
45	99	170	11.4	42.4	10.3	3.67	5.90	3277	105
60	89	175	12.2	40.7	10.1	3.49	5.86	2942	94
75	77	180	10.7	37.3	10.2	3.49	5.65	2291	73
G.M.	93	172	11.5	41.4	10.4	3.76	5.83	3120	100
S.E. (6)	—	—	4.86	7.80	1.16	.186	.0296	197	6.31
C.Ve (%)	—	—	8.4	3.8	2.2	9.9	1.0	12.7	—

Table XVIII
 Experiment K/P 3B. Telok Chengai P.E.S. 1949/50. Treatment Means.

Seedling age (days)	Days from		Tillers per plant	Plant height (in.)	Ear length (in.)	Ear weight (gm.)	Gantang weight (lb.)	Yield	
	Planting to 50% flowering	Sowing to maturity						lb. per acre	% G.M.
30	145	208	10.2	54.1	10.7	4.38	5.98	3858	117
45	131	213	10.7	52.4	10.3	4.07	5.93	3667	111
60	119	218	9.7	51.7	10.8	4.09	5.90	3196	97
75	106	218	8.7	47.9	10.5	4.12	5.86	2512	76
G.M.	125	214	9.9	51.5	10.6	4.17	5.92	3308	100
S.E. (6)	—	—	.269	.642	.253	.129	.0374	39.0	1.18
C.Ve (%)	—	—	5.4	2.5	4.8	6.2	1.3	2.4	—

Earlier planting resulted in generally longer maturation periods but the 3 : 2 ratio of seedling age to maturation period increments is still apparent. Tillering and height again fall-off with age of seedling increase though there is no difference between the 30 and 45 day or between the 45 and 60 day treatments; in both cases figures for the 75 day plants are significantly lowest. No differences in ear length or ear weight appeared, and while differences in grain density are not significant the trend is apparent. All treatments differ significantly in yield, the 30 day plants outyielding the 75 day ones by over 50 per cent.

K/P. 3C.—Seraup Kechil 48

(a) Season 1947/48.

This, a long term variety, was treated in the same way as the other two varieties tested. It flowered with the main crop in each season and suffered no abnormal damage.

Table XIX

Experiment K/P 3C. Telok Chengai P.E.S. 1947/48. Treatment Means.

Seedlings age (days)	Maturation period	Tillers per plant	Yield	
			lb. per acre	% G.M.
30	195	13.2	3424	106
45	203	10.5	3409	105
60	215	11.2	3180	98
75	225	8.5	2903	90
G.M.	210	10.9	3229	100
S.E. (6)	—	.500	139	4.30
C.Ve (%)	—	9.2	8.6	—

A three day increase in seedling age produced a two day increase in maturation period. The 30 day plants gave significantly more, and the 75 day plants significantly fewer tillers than other treatments. As regards yield only the 75 day plants showed a difference in giving a lower yield than the three 30 and 45 day treatments.

(b) Season 1948/49.

Sowing was carried out on 19th July and transplanting from 18th August to 2nd October at the appropriate intervals. The four treatments were 50 per cent in flower on 6th, 11th, 21st and 31st December and matured on 10th, 15th, 30th January and 4th February respectively. No damage from disease or pest occurred. (Table XX).

Table XX
Experiment K/P 3C. Telok Chengai P.E.S. 1948/49. Treatment Means.

Seedling age (days)	Days from		Tillers per plant	Plant height (in.)	Ear length (in.)	Ear weight (gm.)	<i>Gantang</i> weight (lb.)	Yield	
	Planting to 50% flowering	Sowing to maturity						lb. per acre	% G.M.
30	110	175	12.2	55.8	9.94	4.39	5.81	3544	119
45	100	180	10.9	53.0	9.7	3.73	5.84	3048	103
60	95	195	10.8	50.7	9.9	3.86	5.86	2874	97
75	90	200	9.4	50.6	10.2	4.22	5.86	2394	81
G.M.	99	187	10.8	52.5	9.9	4.05	5.84	2965	100
S.E. (6)	—	—	.336	.501	.0619	.173	.0512	96.1	3.24
C.V.e. (%)	—	—	6.2	1.9	1.2	8.5	1.7	6.5	—

Owing to late planting the maturation periods were unusually short for this variety, nevertheless the relation of maturation period to seedling age is similar to that in previous experiments. The effect on tillering was exactly as in the previous year with significant differences between all treatments except the 45 and 60 day ones. Plant heights conform to previous experiments, the 30 day plants outgrowing the 45 day ones, which in turn were taller than the 60 and 75 day plants which did not differ significantly, though the former were slightly taller. Ear measurements do not present a logical picture, the oldest seedlings gave the longest ears and those of the 30 day plants were longer than the 45 day ones, (though this does not appear in the rounded off figures tabulated). In ear weight the only difference occurs between the 30 and 45 day plants. Though error variance was low there are no differences in grain weight/volume ratio. The 30 day plants significantly outyielded the other treatments and the 75 day plants gave the lowest yields; the other two treatments did not differ significantly.

(c) Season 1949/50.

In the third year seed was sown on 2nd June and transplantings were from 1st July to 15th August. Treatments were 50 per cent in flower on 25th, 26th and 30th of November and 3rd December and matured on 2nd, 7th, 9th (60 and 75 day) of January respectively. No damage from disease or pest occurred. (Table XXI).

With the earlier sowing, maturation periods were more normal for this variety and though the expected trend of maturation period is apparent the increment becomes smaller with increasing seedling age. The 75 day seedlings again gave significantly fewer tillers and the 45 day seedlings were significantly best in this respect. The 30 and 45 day treatments gave the tallest plants, the 75 day ones being significantly shorter and the treatments fall into the same order as they do in respect of tillering, both possible indices of vegetative vigour. Ears from the 75 day seedlings were significantly longer than the 45 day ones and heavier than both the 30 and 45 day ears. No fertilizer was used during the course of the experiment and it may be that the nutritional status of the soil is a limiting factor in respect of this variety and an increase in vegetative vigour is offset by the production of smaller ears. On the other hand, the fact that this relationship did not appear in the previous year may have been due to climatic factors limiting yield. Grain from the 60 day treatment was significantly denser than from the other three treatments, which did not differ statistically. The 75 day plants gave the poorest yield and the 60 day ones were also significantly poorer than the younger seedlings. Though the 45 day treatment gave the best yield this did not differ significantly from that of the 30 day treatment.

Summary of Kedah Results

For preliminary examination the results of the nine foregoing experiments are summarised schematically in Table XXII, using the same symbolism as in Table XI. (Table XXII).

Table XXI
Experiment K/P 3C. Telok Chengai P.E.S. Treatment means 1949/50

Seedling age (days)	Days from		Tillers per plant	Plant height (in.)	Ear length (in.)	Ear weight (gm.)	<i>Guntang</i> weight (lb.)	Yield	
	Planting to 50% maturity	Sowing to maturity						lb. per acre	% G.M.
30	147	214	9.3	62.9	10.9	4.45	5.84	3275	106
45	133	219	10.7	63.3	10.5	4.22	5.75	3378	109
60	122	221	9.2	59.9	10.7	4.61	5.98	3107	100
75	110	221	7.2	57.9	11.0	5.20	5.84	2628	85
G.M.	128	219	9.1	61.0	10.8	4.62	5.85	3097	100
S.E. (6)	—	—	.380	.442	.128	.206	.0371	36.9	1.19
C.Ve. (%)	—	—	8.4	1.4	2.4	8.9	1.3	2.4	—

Table XXII
Effect of Increasing Seedling Age, Kedah Trials.

Variety	Haji Haroun			Radin China 4			Seraup Kechil 48		
	1947	1948	1949	1947	1948	1949	1947	1948	1949
Character									
Ripening period	N.R.	(-)	(-)	N.R.	0	0	N.R.	0	0
Maturation period	+	+	+	+	+	+	+	+	+
Number of tillers	=	-	(-)	-	0	-	-	-	-
Plant height	N.R.	=	=	N.R.	-	-	N.R.	=	-
Ear length	N.R.	(-)	(-)	N.R.	(-)	0	N.R.	(+)	0
Ear weight	N.R.	(-)	0	N.R.	-	0	N.R.	0	0
Gantang weight	N.R.	(-)	-	N.R.	-	(-)	N.R.	0	0
Yield	(-)	=	=	=	-	=	(-)	-	=

Key to symbols:—

— Significant (5%) negative effect. = Highly significant (1%) negative effect.

+ Significant (5%) positive effect. @ Highly significant (1%) positive effect.

() Trend, but not statistically significant. N.R. Not recorded.

0 No significant difference or apparent trend.

The table supports the conclusions from the Negri Sembilan experiments that increasing seedling age increases maturation period and decreases tillering, plant height and grain yield and in two of the three varieties decreases grain density. The relationship of seedling age to ear character is not clear, appearing to differ for different varieties and there is possibly an effect on ripening period of the short term variety Haji Haroun.

To confirm and clarify these points the yield data was analysed as a complex serial experiment replicated over three years with two sets of treatments, varieties and seedling age. Other data was subjected to the 'F' test based on pooled error variances with the following results. The entries in the body of the tables are the means of 8 or 12 plots depending on whether records were available for two or three years.

MATURATION PERIOD IN DAYS
Means of 3 Years

Seedling age	H.H.	R.C.	S.K.	Mean
30	138	179	195	171
45	141	186	201	176
60	148	193	210	184
75	155	198	215	189
Mean	146	189	205	180

in an increase in maturation period of two days; there are, however, varietal differences, the longer term varieties being progressively less sensitive. These differences are slight and, with the dry conditions which prevail at this station at harvest, it is possible that the rate of ripening increases as the season advances. The varieties in this experiment, being planted simultaneously, matured progressively. The various seedling age treatments, however, also matured progressively and it may be seen from the following sections that there is little evidence of general ripening rate increasing with time. The differences are therefore varietal.

RIPENING PERIOD IN DAYS
Means of 2 Years

Seedling age	H.H.	R.C.	S.K.	Mean
30	36	29	36	34
45	33	31	38	34
60	30	32	39	34
75	29	32	35	32
Mean	32	31	37	33

As, on all occasions, all replicates of each treatment reached the same degree of ripeness, as judged by eye, on the same day, or variance was apparently negligible and it is assumed that a difference in maturation period of two or more days is significant. The relation is approximately linear in all three varieties, (Fig. 3a). In general an increase in seedling age of five days results

There is little evidence that the ripening period, the period from 50 per cent flowering to maturity, is affected by seedling age; H.H. may possibly be an exception but data are inadequate for a full analysis (Fig. 3b). The effect of increased seedling age on total maturation period is largely the result of the seedling age

Fig. 3A

TRIALS IN KEDAH - TELOK CHENGAI P.E.S.

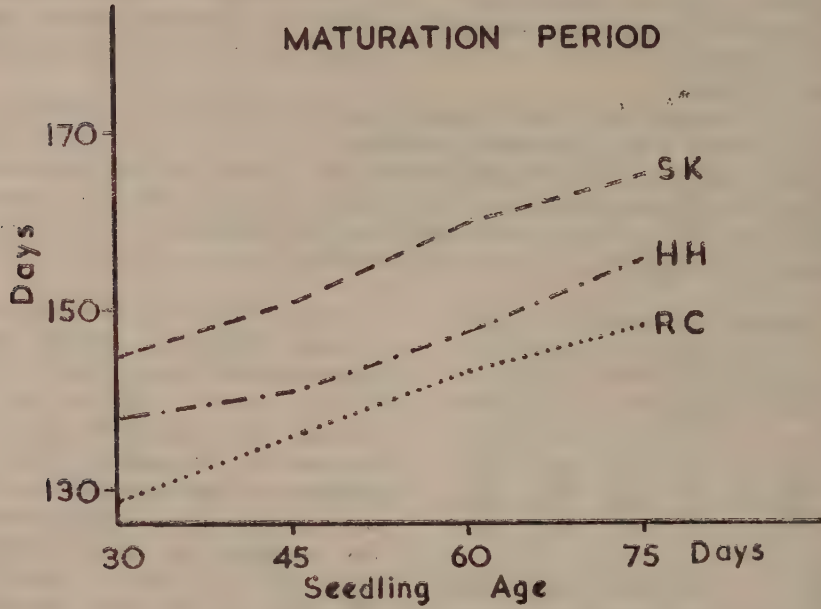
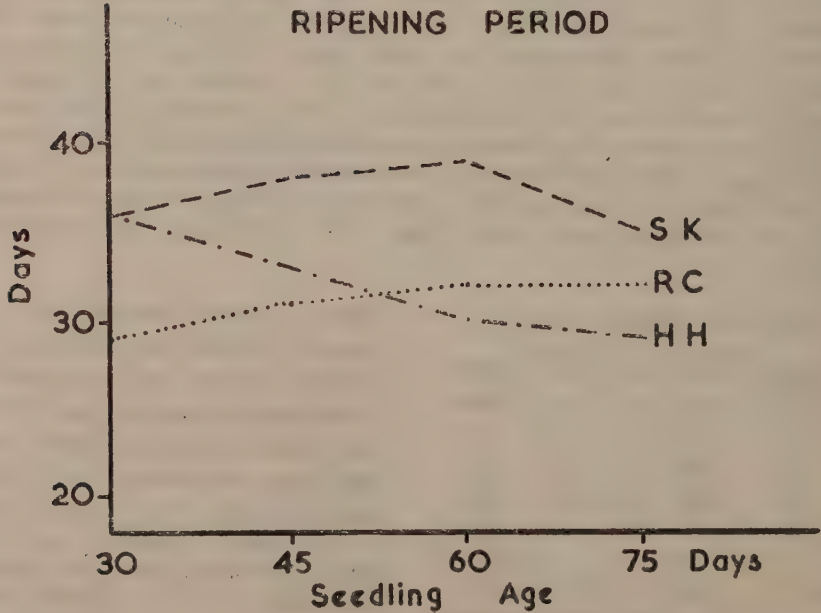


Fig. 3B



itself, as the older the seedlings the sooner they came into flower after transplanting, an increase of five days in seedling age at transplanting hastened flowering by three days on the average.

TILLERS PER PLANT
Means of 3 Years

Seedling age	H.H.	R.C.	S.K.	Mean
30	10.4	12.3	11.6	11.4
45	9.7	11.9	10.7	10.8
60	9.7	10.0	10.4	10.0
75	6.8	9.8	8.4	8.3
M.S.D. 5%	1.25			0.42
Mean	9.1	11.3	10.3	10.2

PLANT HEIGHT
Means of 2 Years

Seedling age	H.H.	R.C.	S.K.	Mean
30	48.5	49.6	59.3	52.5
45	45.2	47.4	58.1	50.2
60	39.4	46.2	55.3	47.0
75	33.9	42.6	54.1	43.5
M.S.D. 5%	1.96			0.80
Mean	41.8	46.4	56.7	48.3

as indicated by both tillering and height of the plant at flowering.

EAR LENGTH
Mean of 2 Years

Seedling age	H.H.	R.C.	S.K.	Mean
30	10.0	10.7	10.4	10.4
45	9.8	10.3	10.1	10.1
60	8.9	10.4	10.3	10.1
75	8.7	10.3	10.6	9.9
M.S.D. 5%	0.48			0.196
Mean	9.3	10.5	10.3	10.1

Graphical presentation suggests the behaviour of the three varieties is similar (Fig. 4a). The falling-off in tillering as seedling age is increased is statistically significant step by step. As regards the individual varieties, though the trend is apparent, only the 75 day treatment differs significantly in H.H. and S.K., while in R.C. the 45 day seedlings have given significantly more tillers than the 60 day ones.

Plant height in inches measured from the soil level to the basal node of the ear of the tallest tiller is also depressed by increasing seedling ages (Fig. 4b). The four treatments all differ significantly both for H.H. and for all varieties. The earlier the variety the more sensitive it is to this effect, as is shown in the table and by the slope of the curves. Evidently increasing seedling age has a marked effect on growth vigour

Ear length in inches appears to vary according to variety (Fig. 5a), probably being dependent on maturation period. The shorter termed H.H. shows a significant decrease in ear length with increasing seedling age, whilst the other two varieties have more or less constant figures.

Fig. 4 A

TRIALS IN KEDAH - TELOK CHENGAI P.E.S.

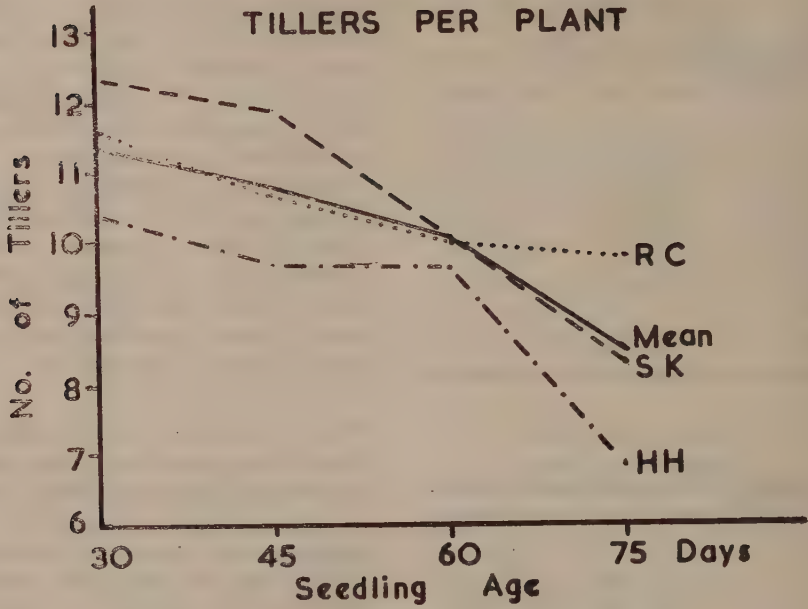
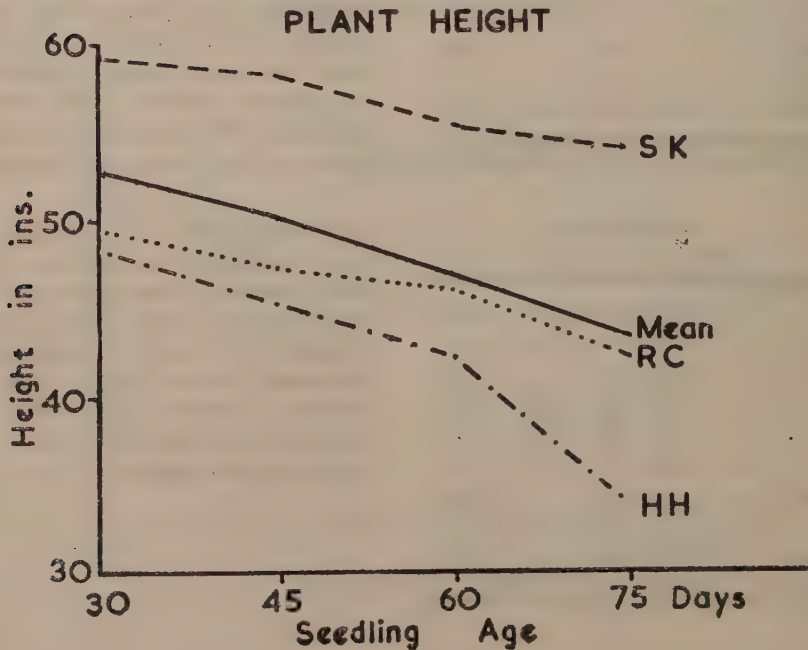


Fig. 4 B



EAR WEIGHT
Mean of 2 Years

Seedling age	H.H.	R.C.	S.K.	Mean
30	4.00	4.39	4.42	4.27
45	3.78	3.87	3.97	3.87
60	2.63	3.79	4.23	3.55
75	3.87	3.80	4.71	3.79
M.S.D. 5%	0.56			0.226
Mean	3.32	3.96	4.33	—

GANTANG WEIGHT

Seedling age	H.H.	R.C.	S.K.	Mean
30	5.59	5.94	5.82	5.78
45	5.54	5.91	5.79	5.75
60	5.43	5.88	5.92	5.74
75	5.43	5.75	5.85	5.68
Mean	5.50	5.87	5.85	5.74
M.S.D. 5%	0.10			0.04

Ear weight in gm. (Fig. 5b) follows much the same pattern as ear length. There are significant differences with H.H.; ear weight tends to decrease with the older seedlings but the behaviour of S.K. is irregular.

In the case of the long term variety there is no significant difference in *gantang* weight attributable to differences in seedling age, but with R.C. 4 and R.H. there is a trend, significant at five per cent in one of the two years, for decrease in *gantang* weight with increasing seedling age.

YIELD

Analysis of the combined results of three varieties and four treatments over three years has been expressed in two ways.

- Yield as percentage of the General Mean for each experiment. (Table XXIII (a)).
- As mean yields. (Table XXIII (b)).

Treatment and varietal differences are all highly significant at the one per cent point tested against both error and interaction.

First order interactions are all significant against error at one per cent but the treatment/variety interaction is not significant against treatment/variety/year interaction. This means that the effect on yield of treatment/variety cannot be assumed to follow a definite course for any variety in any year, but only for the particular varieties under test in these three particular years.

For these three varieties in these three years, as well as for any variety in any year (treatments being significant against interaction), increased yields are obtained by reducing nursery periods to 30 days. Increasing nursery periods by arithmetic increments results in a curvilinearly increasing reduction of yield, viz., 30 to 45 days gives an increment of -223 lb./acre (8.6% G.M.), 45 to 60 by -400 lb./acre (15.5%) and 60 to 75 by -566 lb./acre (21.9%). (Fig. 7).

Fig. 5A

TRIALS IN KEDAH - TELOK CHENGAI P.E.S.

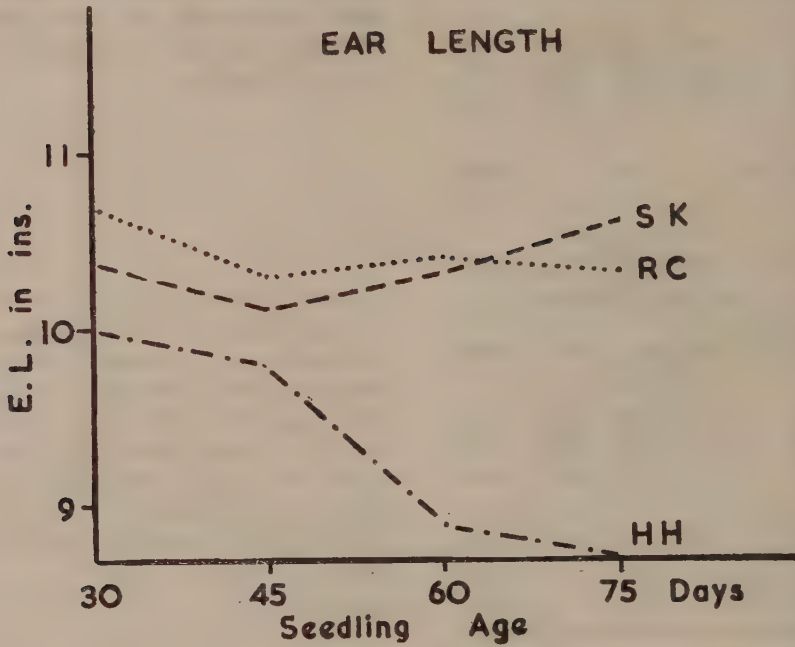


Fig. 5B

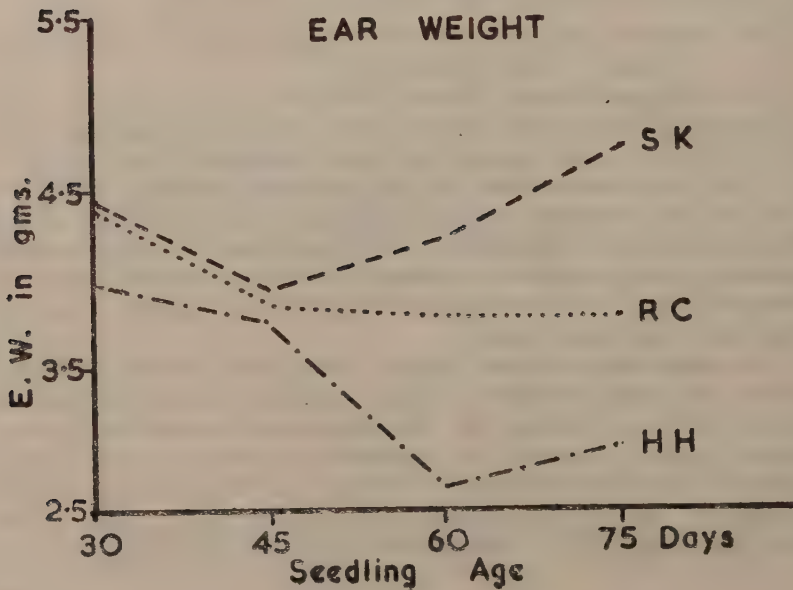


Table XXIII (a)

Yield as % G.M.

Seedling age	H.H.			M	R.C. 4			M	S.K. 48			M	G.M.
	1947	1948	1949		1947	1948	1949		1947	1948	1949		
30	112	140	142	121	122	127	117	122	106	119	106	110	121
45	126	133	101	120	118	105	111	111	105	103	109	106	112
60	113	83	82	92	95	94	97	95	98	97	100	98	95
75	49	43	75	56	64	73	76	71	99	81	85	85	72
	100	—	—	—	100	—	—	—	100	—	—	—	—
	—	100	—	—	—	100	—	—	—	100	—	—	—
	—	—	100	—	—	—	100	—	—	—	100	—	—
	—	—	—	100	—	—	—	100	—	—	—	100	100

Table XXIII (b)

Mean Yields

Seedling age	H.H.		M		R.C. 4		M		S.K. 48			M	G.M.
	1947	1948	1949		1947	1948	1949		1947	1948	1949		
30	7.37	24.58	14.53	15.49	34.91	33.09	32.15	33.39	28.53	29.53	27.54	28.54	25.80
45	8.25	23.38	10.37	14.00	33.66	27.31	30.50	30.49	28.41	25.40	28.15	27.32	23.94
60	7.41	14.67	8.47	10.13	27.06	24.52	26.89	26.16	26.50	23.95	25.92	25.46	20.60
75	3.19	7.56	7.75	6.17	18.34	19.09	20.94	19.46	24.19	19.95	21.90	22.01	15.88
M/Total	6.55	—	—	—	28.49	—	—	—	26.91	—	—	—	20.65
	—	17.55	—	—	—	25.83	—	—	—	24.73	—	22.70	22.70
	—	—	10.23	—	—	—	27.62	—	—	—	25.88	—	21.26
Variety M/Total	—	—	—	11.46	—	—	—	27.37	—	—	—	25.83	21.55
M.S.D. 5%	1.59												0.92

C.Ve = 8.97%

Fig. 6 A

TRIALS IN KEDAH - TELOK CHENGAI P.E.S.

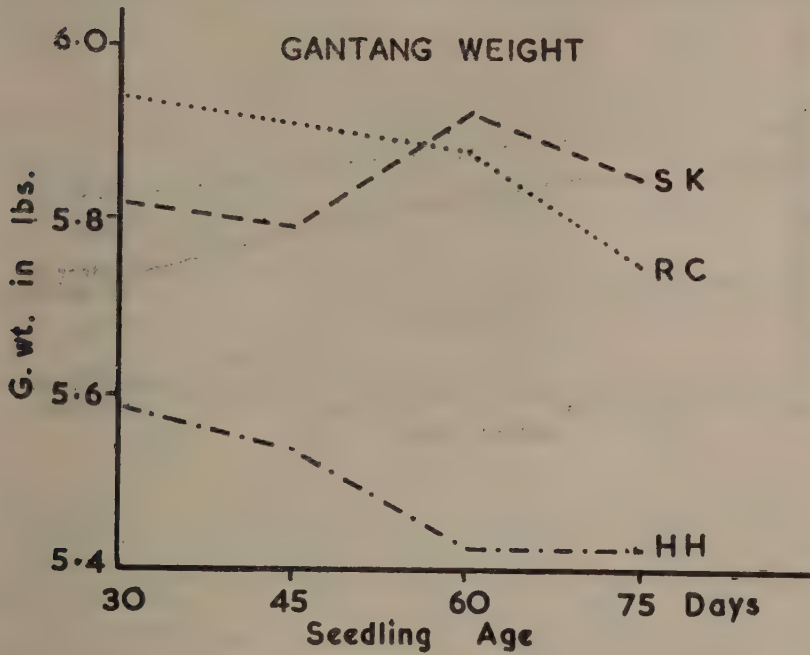


Fig. 6 B

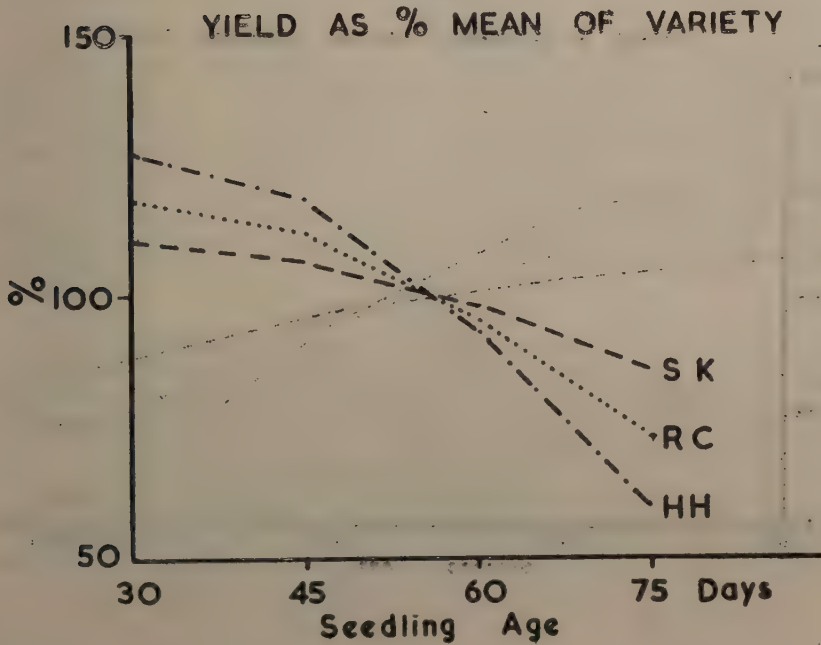


Fig. 7

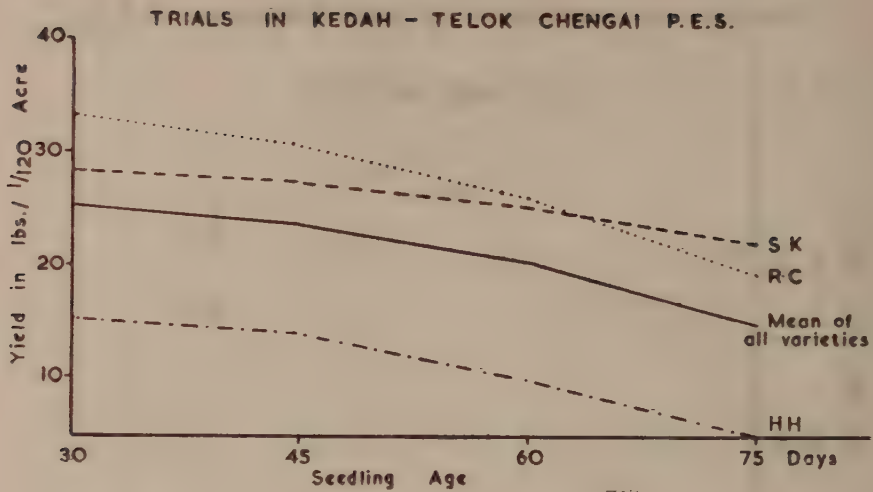
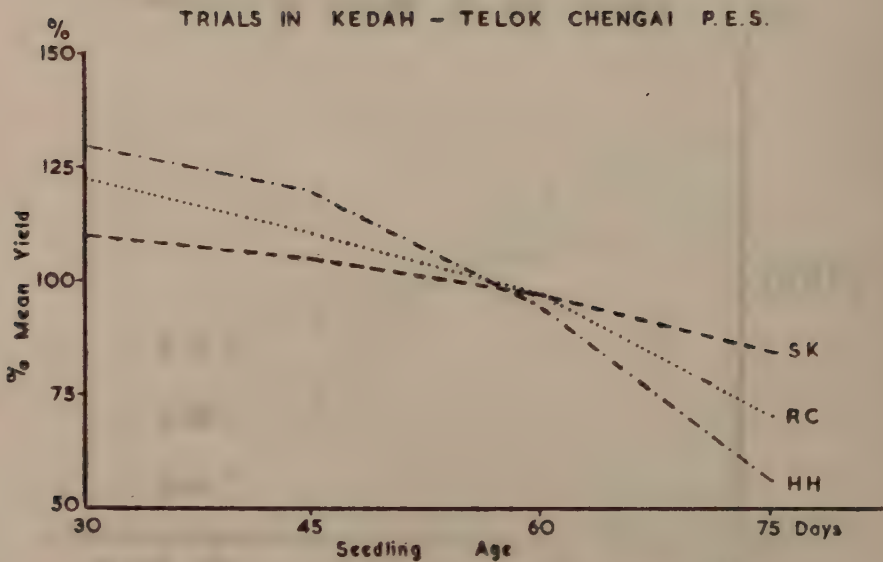


Fig. 8



The reduction of yield from 30 to 45 days is small, being near the borderline of significance at five per cent and may not be applicable to all individual varieties. While there was a significant yield difference between 30 and 45 day plants of R.C.4 amounting to 348 lb./acre (10.6% variety mean), the differences of 179 lb. (4.7%) and 146 lb. (13.0%) for H.H. and S.K.48 respectively were not significant.

The depressing effect of overage seedlings, while common to all varieties, varies in intensity according to variety: it is greatest on R.C.4, less on H.H. and least on S.K.36 as regards total yield but as a percentage of varietal yield it is less on S.K.36 than R.C.4 and most on H.H. as the table below shows. The longer term variety can stand longer in the nursery.

Seedling Age	Depression in yield by increasing seedling age (%)		
	H.H.	R.C.4	S.K.48
30-45	9.6	8.7	4.3
45-60	27.3	14.2	6.8
60-75	39.4	25.6	13.5

Regardless of treatment and year effects R.C.4 will outyield S.K.48 by 185 lb./acre and S.K.48 will outyield H.H. by 1210 lb./acre. This applies also to all six individual variety/year differences except R.C.4/S.K. 48 in 1948 when there was no significant yield difference.

The 1948/49 season was better than the other two, between which there is no difference, but was only better than 1949/50 by 173 lb./acre. This did not distort treatment effects.

Summary

The effects of seedling age on various characters and yield of the rice plant have been studied in ten experiments at five sites over three seasons with three varieties in north and one variety in south Malaya. Results in general agree in both regions.

Increasing seedling age increases the total maturation period and sometimes ear length, decreases tiller number and yield and sometimes ear weight and grain density but has little effect on the ripening period and plant height.

Recommendations

For medium term varieties (180 days) and medium short term varieties (160 days), seedlings in excess of 45 days old should not be used. The experiments also suggest that it would be advantageous in future to investigate the effects of using seedlings less than 35 days old.

Acknowledgement

The success of these trials is due to the conjoint efforts of field and research staff and due acknowledgement to them is gratefully recorded.

THE EFFECT OF DEPTH AND MOVEMENT OF WATER ON THE GROWTH AND YIELD OF RICE PLANTS

BY

R. G. LOCKARD,

Plant Physiologist.

Introduction and Review of Literature

It has been said that the proper control of water is the most important aspect of irrigated paddy cultivation (6). The development of irrigation schemes in Malaya is progressing rapidly under the direction of the Drainage and Irrigation Department. Most irrigation schemes are on the coastal areas in which the land slopes gently to the sea, dropping only a few inches per mile (4). Adequate water is obtained during the growing season by closing the outlets to the sea and diverting river water into the cultivated areas through irrigation canals. When the required depth of water is obtained the drainage gates are opened and the water allowed to escape at a rate that will maintain the desired water depth over the area.

In Malaya, a total water availability of one foot per acre per month over a period of five to six months is considered adequate in the major rice growing areas (4). This refers to the coastal regions where the soil consists of heavy clay and water losses are limited almost completely to evaporation and transpiration. The optimum depth of inundation is considered to be six inches and this depth is maintained throughout the growing season whenever possible (4).

The irrigation practices recommended in different countries vary considerably. In Italy (11) two methods of irrigation are used, (a) continuous submersion and (b) intermittent submersion. In Australia (7) the soil is kept moist until the rice plants are several inches high; water is then applied and gradually increased, with care that the plants are not covered, until the depth is six to nine inches. These fields are dried for harvest. In Ceylon, Lord (9) found that continuous submergence was preferable to periodic drying. However, it was reported by Dzulai (3) in Russia that greater yields could be obtained by periodic irrigation than with continuous irrigation.

In the United States, Jones (8) reported that the rice plants grown in soil kept in a "mucky" condition were shorter and produced lower yields than plants grown on soil submerged in 2, 4, 6, 8, or 10 inches of water. The highest average yield of grain was obtained from the plants grown in soil submerged four inches.

Yoshina and Kawasaki (17) reported that application of irrigation water at an early stage of growth resulted in an early development of tillers. The largest number of tillers was produced when irrigation water was applied at the six-leaf stage. The largest yields of rice were obtained on plots where irrigation water was first applied when the plants had

reached the 9 to 12-leaf stage. Ghosh (5) found that in pots the number of tillers and yield per plant were greater when the water was kept at the soil level than when it was completely drained off. The number of tillers and yield gradually decreased with the progressive rise in water level above the soil surface. Plant height and individual leaf area increased with increasing height of the water level.

In view of the diversity of irrigation practices and the limited nature of experimental results obtained in small scale experiments, there appeared to be a need to test a variety of water regimes under Malayan climatic conditions, in order to determine those treatments which could be most usefully investigated at the soils/water relationships station now under construction. To this end 16 concrete tanks were constructed in the rice cage at Kuala Lumpur in which the water depth and rate of movement could be adequately controlled. These tanks were used for the three experiments reported here. (Plate I).

Each concrete tank, 4 ft. 6 in. wide, 8 ft. long, and 2 ft. 6 in. deep, was divided into two equal parts by a wooden board partition which allowed water flow but prevented the plant roots from passing from one half to the other. The tanks were arranged as a 4 x 4 block suitable for a Latin square design.

The tanks, which had sloping bottoms to facilitate drainage, were water-proofed with bitumen paint. The bottoms of the tanks were filled with a layer of mixed granite chips and covered with 18 in. of sub-soil and 6 in. of top-soil obtained from a few sites in the soils/water relationships station (collection points were not randomly sited). There was one exception to the soil depth in the tanks. In the first experiment where 12 in. of surface water was required, 4 in. of top-soil was not put in place. It was, however, put in place before further experiments were done.

The tanks were irrigated individually from an overhead water supply. Each tank, with the exception noted above, had an overflow outlet 4 in. above the soil surface; when this was closed, the water depth could be increased to 8 in. Each tank held 18 plants.

Methods

Before each experiment the soil in the tanks was puddled and then fertilized at the following rate: sulphate of ammonia, 31 gm. per tank (143 lb. per acre); double superphosphate, 16 gm. per tank (75 lb. per acre); and muriate of potash, 5 gm. per tank (25 lb. per acre). The fertilizers were applied before transplanting, except for half of the sulphate of ammonia, which was applied six weeks later. An additional dressing of sulphate of ammonia (15.5 gm. per tank) was applied about 12 to 14 weeks after transplanting, when the plants began to show signs of shortage of nitrogen.

All seeds were sown in petri dishes and the seedlings were transplanted into the tanks 13, 10 and 9 days later for Experiments 1, 2 and 3 respectively, having received only distilled water during this period.

All measurements were taken on the original shoot; measurements

of the length of leaf sheath were made from the base of the stem to the stipule of the highest sheath and those for plant height were made from the base of the stem to the tip of the tallest leaf on the main stem.

To facilitate the measuring of plants, a narrow strip of board was laid across each tank and basic measurements were taken of the distance from the base of each plant to the board. Subsequent measurements were taken from the board.

The original shoot was included in the tiller count.

EXPERIMENT 1

Treatments

Six varieties of padi were used, one short term (Pebifun—120 day maturation period), one medium-short term (Radin Siak 34—150 day maturation period), three medium term (Serendah Kuning, Radin China 4, and Siam 29—180 day maturation periods), and one long term (Seraup Kechil 36—220 day maturation period). There were three plants of each variety in each of the 16 tanks; eight treatments were applied in duplicate. The treatments were as follows:—

- A. Water depth 4 in. with continuous slow lateral movement but no downward drainage (Control);
- B. As for A, but with downward drainage;
- C. Water stagnant and maintained at a depth of approximately 4 in. by topping up when necessary (rain was not excluded);
- D. Soil just saturated, no downward drainage;
- E. As for A, but the soil was dried in time for harvest of the medium-term varieties;
- F. As for A, but the water was maintained at 8 in.;
- G. As for A, but the water was maintained at 12 in.;
- H. Water depth gradually increased from 1 in. at the time of transplanting to a maximum of 8 in. after 14 weeks and then gradually decreased until harvest time.

Results

The measurements from the base of the main stem to the tip of the tallest leaf and to the top of the leaf sheath are shown in Fig. 1. Examination of these curves shows that, except for the early stimulating effect of treatment G (12 in. of water), there was little effect on growth until 56 days after transplanting. Thereafter treatments appeared to cause some height differences. The most profound effects were obtained in treatments C (stagnant water) and D (water just at surface), the plants of which were shorter than those in other treatments. The other six treatments showed no great differences and no further conclusions can be drawn from these data.

The data obtained at final harvest were averaged over all varieties and are recorded in Table I. There were no marked differential effects of treatment on the six varieties used.

PLATE I



The 16 tanks used for the experiments, showing the wooden partitions.

FIG. 1
GROWTH OF PADI
(DATA FROM EXPERIMENT 1)

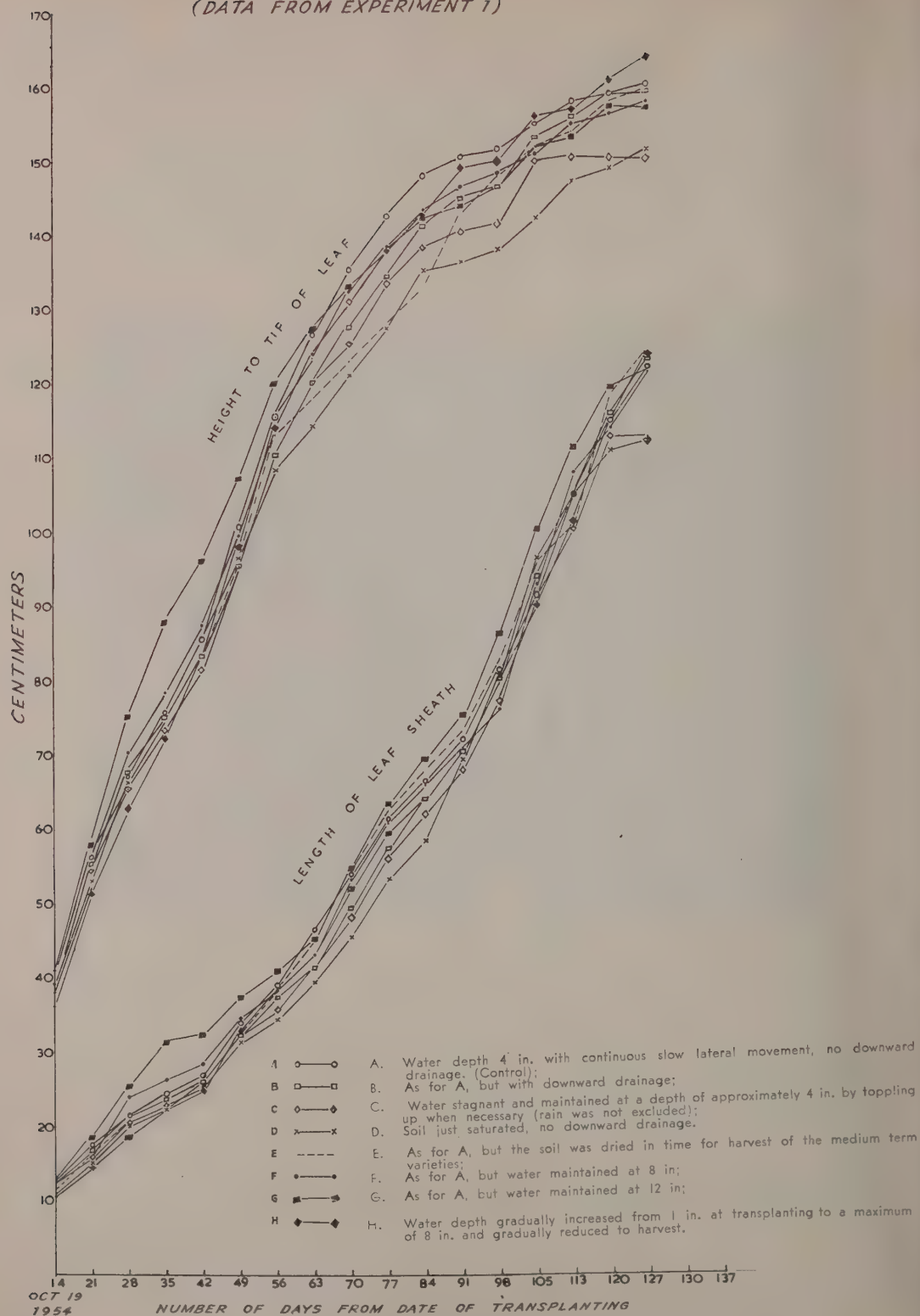


Table I
Results of Experiment 1

	Water Treatments							
	A 4 in. Control	B 4 in. Downward Drainage	C 4 in. Stagnant Water	D Saturated Soil	E 4 in. Soil Dried for Harvest	F 8 in.	G 12 in.	H 1 to 8 in.
1. Height to basal node of ear (cm.)	123.1	121.5	121.3	109.1	126.0	121.1	123.6	120.0
2. Ear length (cm.)	25.3	24.6	25.5	25.3	25.8	25.5	25.5	24.7
3. Grain yield per plant (gm.)	38.7	35.3	35.3	25.0	38.7	45.6	33.2	34.8
4. Grain yield per ear (gm.)	3.2	2.8	3.3	3.2	3.2	3.4	3.1	2.9
5. Number of ears per plant harvested	12.1	12.6	10.7	7.8	12.1	13.4	10.7	12.0
6. Total number of tillers formed per plant	23.0	23.8	23.6	24.4	24.4	21.6	17.6	23.8
7. Estimated grain yield per plant (gm.) *	73.6	66.6	77.9	78.1	78.1	73.4	54.6	69.0
8. Number of days from sowing to maturity	157.8	156.3	157.7	160.8	156.3	155.6	155.5	158.8

* Number of tillers formed x mean weight per ear.

Table II
Percentage of Bored Tillers

Treatment	Days from Transplanting					Percentage of Tillers Lost during Experiment
	39	53	69	83	97	
A	25.0	11.05	14.5	86.1	57.8	47.4
B	37.1	26.9	25.9	54.9	78.2	47.1
C	28.0	18.8	21.0	42.0	61.5	54.7
D	5.0	8.6	25.3	46.1	67.1	68.0
E	38.7	20.7	18.3	36.0	61.8	50.4
F	27.9	15.5	21.7	34.0	55.7	38.0
G	8.9	10.0	16.0	30.6	60.6	39.2
H	14.7	10.4	15.5	38.0	64.9	49.6

The plants in this experiment were severely damaged by stem-borer as shown in Table II. Plants in saturated soil (Treatment D) had only a few bored tillers in the early stages of growth but the number greatly increased in the latter stages of growth. Individual tillers were not inspected to determine the cause of death but Table II shows that the loss of tillers was due primarily to stem-borer.

The plants in saturated soil (Treatment D) had a substantially lower yield but this appeared to be due entirely to the greater loss of tillers in this treatment. Plants in 12 in. of water (Treatment G) produced fewer tillers, but as a comparatively smaller number were lost due to stem-borer attack, yields were similar to the control.

Height to basal node of ear was considerably reduced on plants in saturated soil (treatment D). The reason for this effect is not clear. The results of Experiment 2 indicate that if this was a true effect the difference in growth occurred during the later stages of stem development. It should be noted that the ear length was not reduced by this treatment.

Drying of the soil before harvest (treatment E) had a small stimulating effect on stem length.

Ear length was not appreciably affected by any of the treatments. This was also true for number of days from sowing to maturity (see Table I).

Figure III A shows the rate and period over which tillers were produced in these treatments. Virtually all tillers were formed during the first six weeks after transplanting, regardless of treatment. The effect of deep water (treatments F and G) on tiller formation was to reduce tiller number. The effect was evident in the early stages of growth and persisted throughout the life of the plant.

EXPERIMENT 2

The lack of any definite effect of stagnant water in Experiment 1 made it advisable to repeat this treatment with greater replication.

In another treatment an attempt was made to combine saturated

soil (which had produced a large number of tillers) and 8 in. of water (which had produced a large yield per tiller).

Drying of the soil after flowering is a practical water control treatment and required further investigation.

Treatments

One short term variety (Pebifun—120 day maturation period) was used. There was no downward drainage. The four treatments, in a 4 x 4 Latin square, were as follows:—

- A. Water depth 4 in., laterally moving water (control);
- B. As in A until completion of flowering, after which the soil was allowed to dry;
- C. Water stagnant with sufficient added periodically to maintain a depth of approximately 4 in. (rain was not excluded);
- D. Soil kept saturated until all tillers had formed and water depth then increased to 8 in.; lateral movement of water throughout the experiment.

Results

The growth of Pebifun in this experiment was very similar to the growth of the same variety in Experiment 1. There were no significant differences between treatments on any of the records taken (see Table III). In comparison with Experiment 1 stagnant water (treatment C) and saturated soil (treatment D) did not reduce plant height, nor did treatment D reduce height to basal node of ear. This indicates that in the absence of surface water there was not a real effect on stem length in Experiment 1 or else the difference in growth occurred in the later stages of stem development.

Table III
Results of Experiment 2

Measurement	Water Treatments				S.E. of Treatment Means
	A 4 in. Control	B Soil Dried for Harvest	C Water Stagnant	D 1 in. and 8 in. Depths	
Height to leaf tip (cm.)	138.4	144.5	146.0	140.5	2.67
Length of leaf sheath (cm.)	112.2	112.4	114.3	109.4	1.77
Height to basal node of ear (cm.)	112.2	107.7	114.3	109.4	1.83
Ear length (cm.)	20.6	21.1	20.9	20.2	0.34
Grain weight per plant (gm.)	50.3	50.0	56.1	56.4	3.59
Grain weight per ear (gm.)	3.4	3.7	3.7	3.5	0.20
Number of ears harvested	14.9	15.7	16.4	16.5	0.98
Total number of tillers produced per plant	20.5	20.1	22.8	22.2	2.63
Number of days from sowing to maturity	125.0	124.0	126.0	128.5	1.10

EXPERIMENT 3

The lack of any large differences in the previous experiments was thought to be due to the variable rainfall in Kuala Lumpur, which is unlike the rainfall pattern in most Malayan rice areas. Thus, at the suggestion of Dr. E.W. Russell, the effect of excluding rainfall was examined. The experiment is reported to show the major effect resulting from one method of excluding rain.

Treatments

Two medium-short term varieties (Acheh Puteh and Radin Siak 34—150 day maturation periods) were used. The treatments were arranged in a 4 x 4 Latin square and the varieties were randomised in the half-tanks. There was no vertical movement of water.

Treatments were as follows:—

- A. Fast moving water 4 in. deep, tanks uncovered (Control);
- B. Slowly moving water 4 in. deep, tanks uncovered;
- C. As in A, but tank covered to keep out all rain water;
- D. Tank covered to keep out all rain water. Only sufficient water supplied to maintain a depth of approximately 4 in. (water stagnant).

Plastic sheeting supported by wire netting on a wooden frame was used to exclude rain. Holes were cut for the rice plants and plastic tubing (13 in. diameter) was sealed over each hole and gathered around the plant to keep the rain out.

Fast moving water ran at a rate of 10 litres per hour, which was sufficient to replace the 4 in. of surface water every 24 hours. Slowly moving water ran at the rate of two litres per hour, which was sufficient to replace the 4 in. of water every five days.

Results

Statistical analyses of this experiment were made using the split-plot method, as each tank contained two varieties separated as explained above. With 16 tanks this gave a total of 31 degrees of freedom with 6 degrees of freedom for error (a) and 12 in error (b).

The rate of water flow had no influence on plant growth or yield in any of the records taken. No records showed a significant difference between fast flowing water, treatment A, and slowly moving water, treatment B. Nor was there any measurable effect due to stagnation of the water. The stagnant water, treatment D, was not significantly different from covered fast flowing water, treatment C, in any records taken. The effect of stagnant water may have been masked by the very large effect due to covering the tanks.

In Experiment 3 there were no significant interactions between treatments and varieties in any of the records taken.

Covering the tanks resulted in greatly increased plant growth (see Table IV, V and VI), including ear length (see Table VIII), and it reduced the number of tillers produced (see Table IX). The reduction in tiller number appears to have been due to the lower light intensity

falling on the basal portions of the plants. The maximum water temperature differences between covered and uncovered tanks was 2°C.; between treatments C and A the difference was even less.

Table IV
Final Height to Tip of Leaf

Variety	Treatments				Mean
	A Fast Uncovered	B Slow Uncovered	C Fast Covered	D Stagnant Covered	
		$\pm 4.107_1$	$\pm 3.915_2$		
Acheh Puteh -	137.2	149.7	172.5	165.8	156.3
Radin Siak 34	156.5	164.5	188.3	178.3	171.9
Mean -	146.9	157.1	180.4	172.1	164.1
± 3.034					

¹ For horizontal comparisons.

² For all other comparisons.

Table V
Final Height of Leaf Sheath

Variety	Treatments				Mean
	A Fast Uncovered	B Slow Uncovered	C Fast Covered	D Stagnant Covered	
		$\pm 4.756_1$	$\pm 4.680_2$		
Acheh Puteh -	100.0	113.5	119.3	115.2	112.0
Radin Siak 34	130.1	135.6	153.6	143.2	140.6
Mean -	115.1	124.6	136.5	129.2	126.3
± 3.417					

¹ For horizontal comparisons.

² For all other comparisons.

Table VI
Length of Leaves *

Variety	Treatments				Mean
	A Fast Uncovered	B Slow Uncovered	C Fast Covered	D Stagnant Covered	
		$\pm 1.974_1$	$\pm 2.517_2$		
Acheh Puteh -	37.2	36.2	53.2	50.6	44.3
Radin Siak 34	26.4	28.9	34.7	35.1	31.3
Mean -	31.8	32.6	44.0	42.9	37.8
± 0.855					

* Obtained by taking difference between total height and height of leaf sheath.

¹ For horizontal comparisons.

² For all other comparisons.

Table VII
Height to Basal Node of Ear

Variety	Treatments				Mean
	A Fast Uncovered	B Slow Uncovered	C Fast Covered	D Stagnant Covered	
Acheh Puteh - Radin Siak 34	106.9	$\pm 4.515_1$	$\pm 3.929_2$	121.0	116.5
	129.2	113.3 137.0	124.6 149.2	146.6	140.5
Mean -	118.1	125.2	136.9	133.8	128.5
± 3.559					

¹ For horizontal comparisons.² For all other comparisons.

Table VIII
Ear Length

Variety	Treatments				Mean
	A Fast Uncovered	B Slow Uncovered	C Fast Covered	D Stagnant Covered	
Acheh Puteh - Radin Siak 34	25.1	$\pm 0.470_1$	$\pm 0.459_2$	26.9	26.0
	23.4	25.0 22.4	26.9 26.2	26.9 26.0	24.5
Mean -	24.3	23.7	26.7	26.5	25.3
± 0.340					

¹ For horizontal comparisons.² For all other comparisons.

Table IX
Total Tillers Produced per Plant

Variety	Treatments				Mean
	A Fast Uncovered	B Slow Uncovered	C Fast Covered	D Stagnant Covered	
Acheh Puteh - Radin Siak 34	21.2	$\pm 1.169_1$	$\pm 0.938_2$	14.8	18.5
	21.9	21.5 21.8	16.6 14.0	14.8 12.6	17.6
Mean -	21.6	21.7	15.3	13.7	18.1
± 0.963					

¹ For horizontal comparisons.² For all other comparisons.

The effect on plant growth in the covered tanks was probably nutritional. The plants with fewer tillers had more nutrients available per tiller and therefore made better growth.

The yields did not differ significantly between any of the treatments (Table XI). Although the plants in covered tanks had fewer ears, these ears were longer (Table VIII) and heavier (cf. Tables X and XI). The leaves of plants in covered tanks were substantially longer than those in uncovered tanks (Table VI). The plants in covered tanks had approximately a 30 per cent increase in length of leaves (Table VI) and a 30 per cent decrease in tiller number (Table IX), which indicates that the total area was similar on all plants regardless of treatment. This would explain the absence of difference in yield. The manner of growth of these plants can be seen in Fig. II. The difference between plants in covered and uncovered tanks is evident from the earliest measurements and continues throughout the experiment.

Table X
Number of Ears per Plant

Variety	Treatments				Mean
	A Fast Uncovered	B Slow Uncovered	C Fast Covered	D Stagnant Covered	
Acheh Puteh - Radin Siak 34	5.9	$\pm 1.310_1$ 9.7	$\pm 1.009_2$ 5.5	4.1	6.3
	12.5	12.6	8.3	7.2	10.2
Mean -	9.2	11.2	6.9	5.7	8.3
± 1.099					

¹ For horizontal comparisons.

² For all other comparisons.

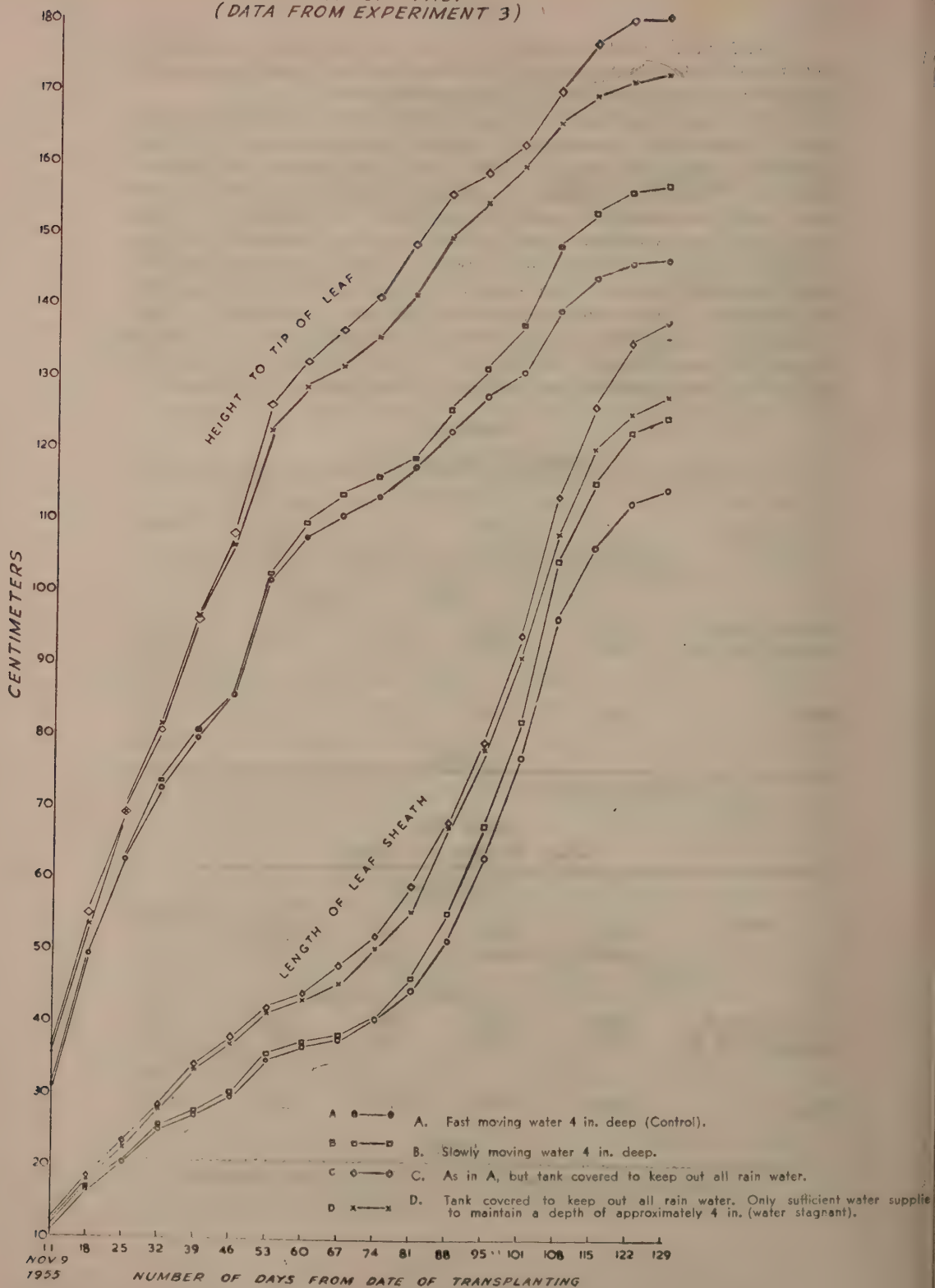
Table XI
Grain Weight per Plant

Variety	Treatments				Mean
	A Fast Uncovered	B Slow Uncovered	C Fast Covered	D Stagnant Covered	
Acheh Puteh - Radin Siak 34	15.0	$\pm 4.642_1$ 25.5	$\pm 3.112_2$ 19.8	14.9	18.8
	34.7	35.9	33.9	29.2	33.4
Mean -	24.9	30.7	26.9	22.1	26.2
± 4.087					

¹ For horizontal comparisons.

² For all other comparisons.

FIG. II
GROWTH OF PADI
(DATA FROM EXPERIMENT 3)



The rate of tiller formation can be seen in Fig. III B. Again, the difference between plants in covered and uncovered tanks can readily be seen. The plants in covered tanks, treatments C and D, had fewer tillers throughout the experiment.

Tillers in Experiment 3 continued to form up to 63 days after transplanting, whereas in Experiment 1 few tillers were formed following the count at 43 days after transplanting (Fig. III A and III B). Experiment 1 was planted in September, 1954, and Experiment 3 in October, 1955. Climatic factors must have influenced the length of time over which the tillers were formed, but treatments did not.

In Experiment 3 as in Experiments 1 and 2 the treatments did not influence the length of the physiological stages of plant development, transplanting to commencement of tillering, commencement of tillering to initial flowering, initial to final flowering, and final flowering to maturity. The number of days from sowing to maturity can be seen in Table XII.

Table XII
Number of Days from Sowing to Maturity

Variety	Treatments				Mean
	A Fast Uncovered	B Slow Uncovered	C Fast Covered	D Stagnant Covered	
		$\pm 1.445_1$	$\pm 1.602_2$		
Acheh Puteh -	160.5	157.3	160.5	159.8	159.5
Radin Siak 34	147.3	149.3	148.3	149.0	148.5
Mean -	153.9	153.3	154.4	154.4	154.0
± 0.898					

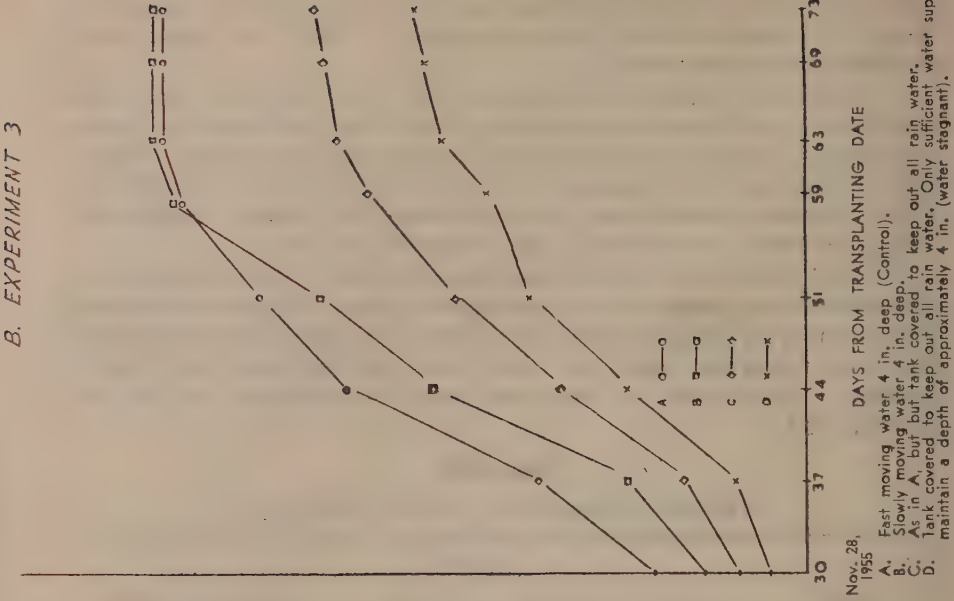
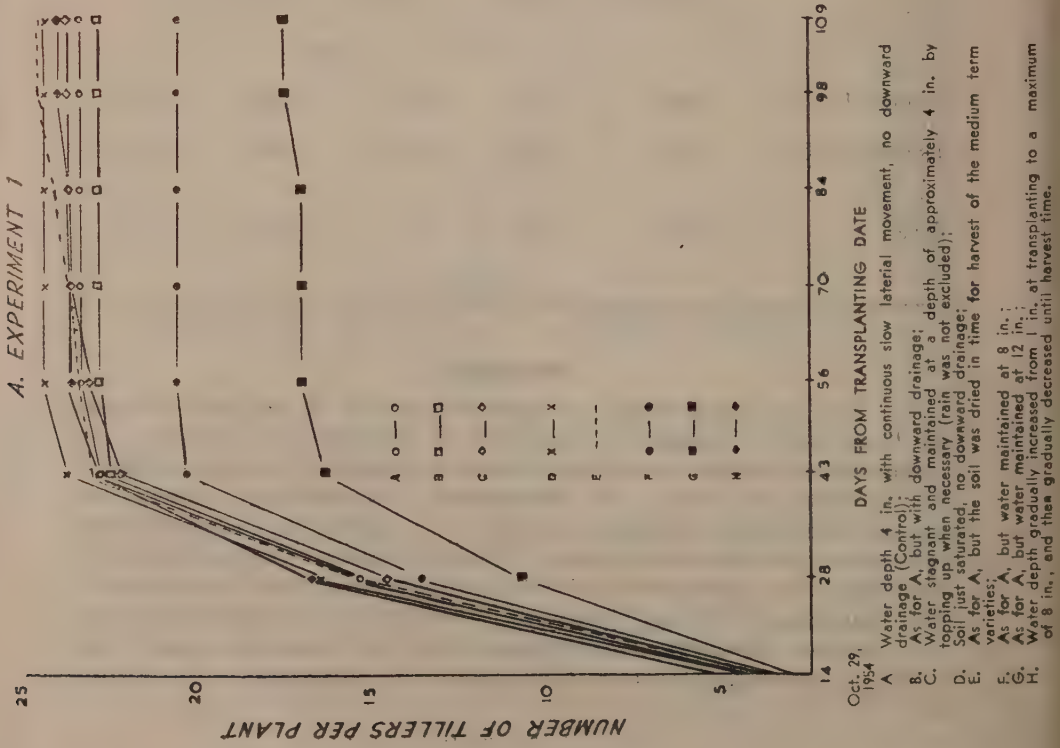
¹ For horizontal comparisons.

² For all other comparisons.

Discussion

The very large effect on vegetative growth of covering the tanks in Experiment 3 cannot be explained by differences in water or soil temperature between covered and uncovered tanks, as this was negligible (a maximum of 2°C.). Air temperature and humidity, although not measured, probably fluctuated more but were unlikely to cause such large differences in vegetative growth. The differences in absorbed oxygen in the water were unimportant, for one set of covered tanks, treatment C, had continuously flowing fresh water. In any case, rice plants can grow in a medium almost devoid of oxygen with their vegetative growth unaffected, providing the leaves of the plants are undamaged (1, 13, 14, 15, 16).

FIG. III
TOTAL NUMBER OF TILLERS FORMED



The factor which appears most likely to have caused the differences in tiller number was a reduced intensity of light falling on the lower portion of the plant. This could also explain the effect of deep water in reducing tiller number in Experiment 1. The plastic cover over the tanks was 0.5 mm. plastic sheet supported by 1 in. wire netting on a wooden frame. Measurements of light intensity under the plastic were not made on the tanks but subsequent measurements, using a photographer's light meter, showed that clean plastic sheet 0.5 mm. thick will reduce the light by approximately 16 per cent. The tubular plastic secured around the opening for each plant and the wire netting undoubtedly reduced further the light reaching the lower portion of the plant.

One of the theories regarding the action of auxin is that light destroys or inactivates auxin (2, 12). The reduction in light intensity on the lower portions of plants in covered tanks may have prevented the destruction of the natural auxin moving into these parts, allowing an accumulation of natural auxin which could prevent tiller formation. This agrees with the results of work by Misra and Sahu (10) who found that seeds soaked in *α*-naphthylacetic acid showed a significant reduction in tiller number, leaf number and plant height.

The absence of the inhibiting effect on plant height may have been due to a normal level of natural auxin in the upper portions of the plants which were subject to normal light conditions.

It was probably the extra nutrients available per tiller which caused the additional growth in height of plants in covered tanks. The main increase in growth was on the leaves, organs which were subject to normal light conditions throughout virtually all of the plant's life.

The absence of any inhibiting effect of stagnant water on plant growth or yield showed that under these conditions stagnation did not appreciably alter the chemistry of the soil. If the oxygen level in the soil decreased it did not affect plant growth or yield. It should be noted that the soil used was rich and had not recently been water-logged.

Conclusions

Increasing the depth of water appeared to decrease the number of tillers formed and, thereby, the yield.

Neither the rate of lateral movement of water nor the presence of stagnant water had any significant effect on the yield of rice.

Plants grown in tanks covered with plastic sheeting behaved quite differently from plants in uncovered tanks. Plants in covered tanks:

- (a) were larger;
- (b) had longer ears;
- (c) had fewer tillers;
- (d) but did not yield less than plants in uncovered tanks.

Varying the water depth or rate of water movement did not appreciably alter the lengths of physiological stages in the development of the rice plant.

The effects of different depths and rates of movement of water did not differ between varieties.

Summary

The results of three experiments carried out in 16 cement tanks are reported.

Experiment 1 included six varieties of padi and eight different water-control treatments.

Experiment 2 was carried out on one variety with four water-control treatments in a Latin square design.

Experiment 3 was carried out on two varieties with four water-control treatments in a Latin square design.

The results are discussed and conclusions are presented.

Acknowledgement

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FUNGICIDAL TREATMENT OF PADI SEED

BY

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Introduction

Preliminary experiments on the treatment of padi seed with a mercurial seed dressing have been described by Cherewick (1). The object of these experiments was to discover whether seed-borne diseases could be reduced by such means and also to find out whether seed treatment resulted in improved germination. The results reported in his paper indicated that such seed treatment did result in a decrease in the number of diseased seedlings and also, in most cases, in an increase in percentage germination. Greater increases were obtained with old seed of reduced viability than with fresh seed.

More recently this work has been followed up by further investigations into the seed treatment of padi. To obtain fuller information on the effect of treatment on percentage germination than was afforded by the preliminary observation tests previously carried out, several replicated laboratory tests were laid down. In these, different seed dressings were compared and the effect of treating the seed before or after soaking was investigated. In addition, field nursery trials were carried out to discover whether the results of laboratory tests were applicable under field conditions.

The main object of padi seed treatment is to inhibit the growth of any fungi infecting the seed so as to prevent them from attacking the germinating seedling. An investigation was carried out to discover what fungi are present on padi seed in Malaya and which of these fungi are capable of attacking young seedlings and so of reducing germination. The results of this investigation are recorded in the first part of the paper and are followed by a report on the seed treatment experiments.

The Fungi Infecting Padi Seed

OCCURRENCE AND IDENTITY OF THE FUNGI

In this investigation into the composition of the fungus flora of padi seeds, samples of seeds from five localities in Johore, Province Wellesley and Selangor were examined. To isolate the fungi from the seeds the method used was to sow the seeds in petri dishes on damp, sterile filter paper. One hundred seeds from each sample were sown without treatment, while one hundred were germinated after surface sterilisation with a 0.1 per cent aqueous solution of mercuric chloride. The germinating seeds were examined frequently and all fungi found growing on them were transferred to agar slopes on which pure cultures were established. The fungi were then identified as far as possible

Table I lists the different fungi obtained. The frequency with which they were isolated is also shown. In the Table it will be seen that the total number of fungi recorded exceeds in some cases the total number of infected seeds. Where this occurs it indicates that more than one fungus was isolated from one seed.

Table I
The Fungi Isolated from Padi Seed

Padi Variety	Origin of Seed	Surface sterilised (+) or not (-)	Number of seeds out of 100 yielding										Unidentified fungi	Total number of infected seed
			<i>Aspergillus niger</i>	<i>Aspergillus tamaris</i>	<i>Curvularia</i> spp.	<i>Fusarium</i> spp.	<i>Fuscladina</i> sp.	<i>Helminthosporium oryzae</i>	<i>Penicillium vermiculatum</i>	<i>Rhizopus cohnii</i>	<i>Syncephalastrum racemosum</i>	<i>Trichoconis padwickii</i>		
Siam	Johore	+	2	—	—	17	—	20	—	4	—	—	—	43
		+	—	—	—	2	—	31	—	—	—	—	—	33
Pebifun	Province Wellesley	+	—	—	—	—	—	6	4	7	—	33	—	41
		+	—	—	—	—	—	4	—	—	1	19	7	28
Serendah	Johore	+	—	3	—	1	14	7	—	—	—	1	2	28
Kuning		+	—	—	—	—	—	—	—	—	—	—	—	—
"	Selangor	+	—	—	1	—	2	13	—	4	—	—	3	23
"		+	—	—	—	61	—	—	—	—	—	11	11	77
		+	—	—	—	63	—	—	—	—	—	10	19	74
Nachin	Johore	+	—	—	3	2	6	7	—	7	—	5	6	32
Puteh		+	—	—	—	—	—	—	—	—	—	—	—	—
"	"	+	—	—	6	—	1	3	—	—	—	—	2	12

In all cases surface sterilisation resulted in a reduction in the number of seeds from which fungi could be recovered. Thus in the five samples tested the average proportion of infected seed was 44.2 per cent in the case of untreated seed, compared with 34.0 per cent in the case of surface sterilised seed. This reduction but not elimination of infection by surface sterilisation demonstrates that although some of the fungus infections are external on the padi grains, the majority of the fungi associated with the grain are borne internally.

The fungus species most commonly isolated was *Helminthosporium oryzae* Breda de Haan, which affected 9.1 per cent of the seed. This was followed by *Trichoconis padwickii* Ganguly, which was isolated from 7.9 per cent of the grains. Also collectively common were species of *Fusarium* which together occurred on 14.6 per cent of the seeds. *Trichoconis padwickii* and the species of *Fusarium*, as well as most of the other commonly occurring fungi, were more frequently isolated from untreated than from surface sterilised seed. An exception to this was *Helminthosporium oryzae* which was isolated more frequently from surface sterilised seeds (from 10.2 per cent of the seeds as compared with 8 per cent of the untreated seeds).

As can be seen from Table I, most of the species of fungi were recovered from both surface sterilised and unsterilised seeds but the moulds *Aspergillus niger* v. Tiegh., *A. tamarii* Kita and *Penicillium vermiculatum* Dangeard only occurred on the untreated seeds, indicating that they were only present as surface contaminants.

THE PATHOGENICITY OF THE FUNGI

Artificial infection tests were carried out to discover which, if any, of the fungi isolated from the padi grains were capable of damaging germinating seedlings. For these tests the fungi were grown in a sterilised mixture of coarsely-ground maize and sand in conical flasks. When this medium was thoroughly permeated by the fungus it was added to eight-inch pots of steam-sterilised soil, the inoculum being well mixed with the top inch of soil. Padi seeds from samples showing a low amount of internal fungal infection were used in these tests. They were surface sterilised with a 0.1 per cent aqueous solution of mercuric chloride, soaked in sterile water for 24 hours and planted in the inoculated soil. Fifty seeds were planted in each pot. Similarly treated seeds from the same samples were also sown as a check in pots of sterilised but uninoculated soil.

Ten to fourteen days after planting the seedlings were examined for fungal infection. The proportions of healthy uninfected seedlings found in inoculated and uninoculated pots are given in Table II.

Table II

The Effect of Fungi on the Growth of Padi Seedlings

Fungus	Percentage healthy seedlings in check pots	Percentage healthy seedlings in inoculated pots	Estimated percentage seedlings attacked by fungus
<i>Helminthosporium oryzae</i> -	95	4	96
<i>Fusicladina</i> sp. -	90	43	52
<i>Curvularia</i> sp. -	96	55	43
<i>Trichoconis padwickii</i> -	84	68	19
<i>Penicillium vermiculatum</i> -	96	94	2
<i>Syncephalastrum racemosum</i>	99	98	1
<i>Aspergillus niger</i> -	70	70	0
<i>Aspergillus tamarii</i> -	99	99	0
<i>Fusarium</i> spp. -	96	96	0
<i>Rhizopus cohnii</i> -	99	99	0

The difference between the numbers in the first and second columns of this table give figures representing the number of seedlings attacked by the various fungi. These figures, expressed as percentages of the number of healthy seedlings in the check pots are shown in the third column.

Of the ten fungi investigated only four had any seriously deleterious effect on the germinating seedlings, the other six species being harmless moulds. Of the four pathogenic species *Helminthosporium oryzae* was by far the most virulent parasite, 96 per cent of the seedlings

being attacked by this fungus and 82 per cent being killed. Comparable figures for the other harmful fungi were 52 and 32 per cent for *Fusidina* sp., 43 and 20 per cent for *Curvularia* sp. and 19 and 14 per cent for *Trichoconis padwickii*.

Seed Treatment Experiments

LABORATORY EXPERIMENTS

Two series of laboratory experiments were undertaken.

In the first series the performance of four seed dressings (three dusts and one liquid) on six varieties of padi was compared. These dressings included one whose active ingredient was tetramethylthiuram disulphide (Fernasan) and three organic mercurial compounds (Agrosan GN, Tillex dry dressing and Tillex wet dressing).

In this series seeds were germinated in eight-inch pots of soil, 100 seeds in each pot, one pot representing a plot. The pots were arranged in a randomised block layout with six replications. The soil was kept moist, to simulate as far as possible conditions normally found in padi nurseries, by immersing the pots in trays of water. Seeds in this series were not soaked before planting. The dry dressings were used at the rate of 0.5 gms. to 100 gms. of padi. The wet dressing was used at a 20 per cent dilution, the seeds being soaked in this for ten minutes, after which they were dried for a short time before planting.

The effect of treatment was assessed by counting the number of healthy seedlings produced, counts being made three weeks after planting. The results of these tests are summarised in Table III.

Table III

First Series of Laboratory Experiments on the Effect of Seed Dressing on Germination.

Figures show mean number of healthy seedlings per plot of 100 seeds.

Test No. Padi Variety	1A Machang	1B Nachin 11	1C Seri Raja	1D Reyong 20	1E Mayang Sabatil	1F Serendah Kuning 48
Agrosan GN	84.5	12.7	42.0	27.8	61.3	14.7
Tillex dry dressing	94.8	12.2	46.3	27.5	60.3	19.3
Tillex wet dressing	89.5	12.8	30.2	29.1	56.5	13.0
Fernasan	67.8	8.8	40.2	24.0	65.1	20.0
No treatment	56.7	7.0	27.3	18.5	53.5	9.3
Standard Error (20 degrees of freedom)	6.24	1.67	3.99	3.82	N.S. *	2.50

Layout: x 6 randomised block.

* N.S. indicates F not significant at 5 per cent probability level.

In these tests the dry mercurial dressings gave the most consistently good results, both Tillex dry dressing and Agrosan GN giving, at the five per cent probability level, a significant increase in germination in five tests. Tillex wet dressing gave a significant increase in germination in only three tests and Fernasan in two. The greatest increase in germination obtained was 38.1 per cent, while the average increase over all six tests was 11.3 per cent.

Germination of the seed used in the above tests was rather poor. In the second series five tests were carried out on seed (variey Siam) giving better germination. Each test was planted in a water-tight tray, four feet square, containing soil. Plots, arranged in a randomised block design with six replications, were six inches square and, as in the first series, each contained 100 seeds. As before, the soil was kept moist to simulate natural conditions. To accord with the normal local practice, the seeds were soaked before planting. Treatment with the seed dressing before soaking was compared with treatment after soaking. In the latter case the seeds were surface dried before the fungicide was applied.

In the first test of this series Agrosan GN and Tillex dry dressing were compared; in the others the two forms of Tillex were used. The dusts were used as in the first series but the Tillex wet dressing was diluted with its own volume of water, the mixture being applied at the rate of 0.1 mls. to 12 gms. of seeds. The results of these tests are summarised in Table IV.

Table IV

**Second Series of Laboratory Experiments on the Effect of
Seed Dressing on Germination.**

Figures show mean number of healthy seedling per plot of 100 seeds.

Test No.		3B			5A	5B	5C	5D
Fungicide	Before or after soaking		Fungicide	Before or after soaking				
Agrosan GN	Before	72.1	Tillex, wet dressing	Before	90.3	82.0	81.1	78.6
	After	88.6		After	88.8	87.1	86.0	77.8
Tillex, dry dressing	Before	88.1	Tillex, dry dressing	Before	91.1	89.6	82.3	77.3
	After	86.5		After	88.6	87.8	84.3	79.6
No treatment		79.6	No treatment		89.0	79.8	84.0	74.0
Standard Error (20 degrees of freedom)		4.41			N.S.	2.99	N.S.	N.S.

Layout: x 6 randomised block.

In four of the five tests seed treatment had no effect on germination. In the remaining experiment all treatments except Tillex wet dressing

applied before soaking gave a significant increase in germination at the five per cent probability level. Increases in germination in this second series of tests were of a much lower order than in the first, the greatest increase being 9.8 per cent.

FIELD EXPERIMENTS

To discover whether results comparable with those obtained in laboratory experiments were likely to be obtained under field conditions, a series of experiments was laid down at Padi Test Stations at Ampang Tinggi and Kendong in Negri Sembilan and at the Padi Experiment Station at Pulau Gadong in Malacca. In these tests the experimental nurseries were laid down in the normal planting season and were planted under conditions similar to those under which the other nurseries on the Stations were planted.

Plots contained 100 seeds and were surrounded by low wooden partitions to prevent accidental mixing of the seeds after planting. As before, a randomised block design with six replications was used. The fungicides tested were Tillex wet seed dressing, applied after soaking of the seeds, and Agrosan GN, applied either before or after soaking the seeds, or to the dry seed which was then planted without soaking. The wet dressing was applied as in the second series of laboratory experiments, while the dust was used at the rate of 0.3 gms. to 100 gms. of padi.

The results of these experiments are summarised in Table V.

Table V

Field Experiments on the Effect of Seed Dressing on Germination.
Figures show mean number of healthy seedlings per plot of 100 seeds.

Test No.	8A(1)	8A(2)	8B	8D	8F
Padi variety	Serendah Kuning	Serendah Puteh	Serendah Puteh	Reyong 6	Cuttack HC 58
Station	Kendong	Kendong	Ampang Tinggi	Pulau Gadong	Pulau Gadong
Agrosan GN before soaking seed	86.5	86.3	90.1	90.8	64.8
Agrosan GN after soaking seed	89.8	61.6	88.5	91.6	69.3
Agrosan GN without soaking seed	83.0	83.8	76.3	90.1	66.0
Tillex wet seed dressing	92.3	82.6	82.5	93.1	66.6
No treatment	91.7	84.6	90.8	94.1	51.5
Standard Error (20 degrees of freedom)	2.71	3.42	N.S.	N.S.	N.S.

Layout: x 6 randomised block.

In these tests none of the treatments with seed dressing resulted, at the five per cent probability level, in a significant increase in germination.

On the contrary, treatment of unsoaked seed with the dry dressing resulted in a significant decrease in germination in one test, as also did treatment of seed after soaking with the same dressing.

Although the number of seeds germinating was taken as the main criterion for judging the effect of seed dressing, observations were also made on seedling growth. In many of the tests, both in the laboratory and in the field, it was noted that the early growth of the seedlings was stimulated by treatment, the effect usually being most noticeable about one week after planting. Later the effects of this early stimulation of growth disappeared. This is exemplified by the figures given in Table VI, which were obtained from the field trials described above. The seedlings were weighed when three weeks old.

Table VI

Field Experiments on the Effect of Seed Dressing on Seedling Growth.
Figures show the mean oven dry weight of one seedling in mgms.

Test No.	8A (1)	8A (2)	8B	8D	8F
Agrosan GN before soaking seed	140.2	124.5	40.0	63.3	23.2
Agrosan GN after soaking seed	136.2	134.0	40.7	64.8	23.5
Agrosan GN without soaking seed	139.8	108.8	32.0	59.7	24.0
Tillex wet seed dressing	135.3	119.0	40.0	62.2	21.8
No treatment	132.5	148.3	37.2	59.5	21.5
Standard Error (20 degrees of freedom)	N.S.	11.60	N.S.	N.S.	N.S.

Layout: x 6 randomised block.

When, as in this table, growth is assessed by the mean weight of individual three-week old seedlings, no stimulation of growth can be demonstrated. Indeed, the only significant figures (at the five per cent probability level), occurring in only one experiment (8A(2)), show a depression of growth in two treatments (Agrosan GN applied without soaking and Tillex wet dressing).

Discussion

The seed treatment experiments described above give a fairly clear indication that with fresh seed giving a high percentage germination seed dressing is unlikely to be of benefit. It neither increases the number of healthy seedlings produced nor results in improved or quicker seedling growth, except for a slight boost to growth in the first week or so after germination, the effects of which soon disappear. With older seed of reduced viability, however, the experiments show that some benefit may result, percentage germination being improved.

Of the small number of different seed dressings tested, the organic

mercurial dusts proved the most consistently effective. They also have the advantage that they are easier to apply evenly than is a wet mercurial dressing. The latter, perhaps because of this difficulty, tended to give erratic results.

No consistent difference in the effect of treating the seed before or after soaking was detected. As the mercurial dressings are poisonous it would be safer to apply them after soaking of the seed, so that the danger of accidental use of treated seed for consumption would be avoided. The possible washing off of the seed-dressing from seed treated before soaking, although it did not appear to happen in the experiments under discussion, is another factor of the post-soaking treatment.

Investigation of the fungi infecting padi grains showed that *Helminthosporium oryzae* was both the commonest fungus present and also the most damaging to young seedlings. The other species capable of attacking seedlings appear to be of comparatively minor importance.

All the harmful fungi were found to be able to infect the grains internally. They cannot, therefore, be eliminated by treatment with a seed dressing. This at least partly explains the generally poor response obtained from seed dressings.

Summary

In a study of the fungus flora of padi seeds, *Helminthosporium oryzae* was found to be the commonest fungus present and also the most harmful to young seedlings.

Laboratory and field experiments on padi seed dressing showed that no benefit resulted from the treatment of fresh seed giving a high percentage germination. Improved germination was obtained by dressing older seed of reduced viability.

Organic mercurial dusts were found the most suitable of the materials tested.

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NOTES ON CURRENT INVESTIGATIONS AND EXTENSION WORK

July to December, 1958.

Weather

During the period under review water shortage affected the growth and yield of padi in many areas, particularly in the north, where planting was delayed some three to four weeks.

Padi

Research

Final analysis of all botanical trials carried out in the 1957/58 season has been completed and programmes for the coming season have been finalised and distributed to all States. Sowing and transplanting have been slightly delayed in Kedah, Perlis and Malacca due to lack of rain but elsewhere conditions have been normal.

Results not previously reported include the following:

- (i) In Kedah and Perlis trials of new Radin Ebos selections indicate that R.E. 64 is likely to be the most adaptable and highest yielding strain.
- (ii) In the North Krian area of Perak, Mayang Sabatil 20 and 69 have been the most successful new selections of this variety but have outyielded the standard, Mayang Sabatil 8, a pre-war selection, by only six per cent.
- (iii) In the Temerloh and Kuala Lipis areas of Pahang new Serendah Kuning selections have given excellent results, outyielding the local variety Seri Menjadi by over 30 per cent. In other parts of the State unselected Serendah Kuning appears to be higher yielding than the local riverine varieties now grown.
- (iv) In the Kuala Trengganu area the local long term variety Lembu Basah has significantly outyielded seven other such varieties giving a mean yield of over 3500 lb. per acre over three years.

Limited extension trials using Seraup 50 have been carried out in North Krian and in 20 sites out of 21 it outyielded the local variety.

A further pot experiment on control of padi stem borers is now in progress at Kuala Lumpur and field experiments have been initiated in all States.

Two Japanese scientists provided by the Colombo Plan are working with the Research Branch. One, a plant breeder, is stationed at Bukit Merah padi experiment station in Central Province Wellesley and is engaged on selecting new varieties from indica and japonica crosses and in testing Japanese varieties as suitable parents for future crosses. The other, an entomologist, has initiated a comprehensive programme on padi stem borers in north-west Perak and Province Wellesley.

The first series of pot trials *penyakit merah* has been completed and is being followed up by field trials in the same areas from which soils for the pot trials were collected. Phosphate and lime are the most important fertilizers on all types of soil tested and several soils appear to be deficient in manganese.

In lodging experiments with progenies of X-rayed Siam 29 no lodging has occurred in the X-rayed progenies while the ordinary Siam 29 controls show signs of lodging.

Cadung Ket which has done well on *bris* soils in Kelantan has been a total failure on *gelam* soils in Malacca. On the normal Station soils of Malacca growth of this variety is good. Some 81 varieties from F.A.O. and Burma (listed as "intermediate") have been grown in pots at Kuala Lumpur for observation. Most have now flowered and a few varieties are ultra-early, maturing in approximately 100 days. The majority have a maturation period of 120 to 150 days. Many of the varieties appear to have good grain types and growing habits and show promise for future work on double cropping.

Sand culture experiments are nearly complete and most of the plants have been harvested. Deficiency symptoms of N, P, K, Ca, Mg, Fe, Mn and Zn and toxicity symptoms of B and Mn have been induced. It has not been possible to induce deficiency symptoms of B, Cu or Mo.

Considerable progress has been made in the construction of the Soils Water Station at Sungei Burong. The greater proportion of the work on the bunds, drains, water controls and pump house has been completed.

Surveys of stem borer damage at flowering have been carried out in Perlis, Kedah, Penang and Province Wellesley and Perak. Each survey was done at 30 sites. Results of the 1957/58 experiments on padi stem borer control show that a reduction in attack and an increase in yield can be obtained in heavily infested areas by fortnightly spraying with Dieldrex 15. One spray, four weeks before flowering, was not effective.

In a field trial at Ampang Tinggi, Negri Sembilan, it has been shown that phosphate and nitrogen are essential for good growth of padi in the area. It was found that nitrogen deficiency symptoms developed even after the addition of 60 lb. N per acre. A further addition of 30 lb. N per acre rectified the deficiency.

Samples of padi plants have been taken from nurseries at Sekinchan and Ampang Tinggi, the former a high yielding and the latter a low yielding area. It was found that the dry weight of plants from Sekinchan was 4 to 30 times as great as the dry weight of plants of similar age from Ampang Tinggi.

Agronomic Investigations and Extension

Plans for planting and laying out of field experiments were executed during the quarter at Telok Chengai and Pulau Gadong Padi Experiment Stations. At Telok Chengai, Kedah, planting was carried out somewhat later than usual as a result of water shortage consequent

on an extended period of drought; nevertheless, the crop was growing satisfactorily at the end of the quarter. The agronomic research programme for the 1958/59 season involves fewer investigations than last year on both Experiment Stations and cultivators' land. The majority of the work is confined to the Kedah/Province Wellesley area, where it is under the direction of an agronomist. One large scale formal trial is, however, being conducted on Agricultural Stations in Kelantan and there are a few formal trials in progress at Pulau Gadong Padi Test Station in Malacca.

Formal trials being conducted on padi test stations include field and nursery manurial trials; investigation of suitable types and levels of phosphate; trials designed to determine the best age for seedlings at transplanting; investigation of the effect of manuring overaged seedlings and a trial intended to clarify how best to utilize padi straw. At Bukit Merah Padi Test Station, in Province Wellesley, investigations are in hand to study the economics of double cropping. Two newly designed formal trials have been put down at Pulau Gadong Padi Test Station to investigate the effect of different spacings at transplanting using both fixed and variable plant densities per acre. In addition to these formal trials an increased number of exploratory observations are being conducted this season on Padi Test Stations. These are intended further to clarify specific problems such as placement of fertiliser, spacing and suitability of complete fertiliser mixtures.

The number of trials on cultivators' fields has again been reduced this season in a further attempt to clarify the reason for unexplained variations in results which have occurred in past years. It is believed as a result of last season's investigations that differences in nursery management techniques are partly responsible for the variation. The effects of management on vigour and growth of seedlings seems to mask to a considerable extent the influence of fertilisers on padi transplanted in the field.

At the padi mechanisation scheme at Parit in Perak a total of 55 acres of land had been satisfactorily levelled by the end of the quarter. This has since been cultivated and drilled with padi and the latter was growing well at the end of the quarter. Water supply has been satisfactory. During the past off-season, observation plots of soya bean have provided a very satisfactory return. A yield of 1,000 lb. per acre of beans was obtained from one of the varieties grown, the retail value of which is approximately \$340. In view of the success achieved a larger area of this crop will be sown and managed with mechanical equipment in the 1959 off-season.

Pulau Gadong Padi Experiment Station has suffered from lack of water. Two trials have had to be abandoned for this season due to serious pest attack. Observations laid down on the East Coast with a complete fertiliser are showing some very interesting effects. The mixture, 14 : 12 : 9, sells at a price in the same range as the present subsidised *baja padi* mixture on equivalent nutrient content basis and

it will be interesting to follow up initial observations during the next padi season.

Sowing of nurseries for the off-season padi crop in Province Wellesley was undertaken in April/early May. The total area planted was 7,650 acres, comprising 520 acres in Province Wellesley North, 7,000 acres in Central, and 130 acres in South. Plant growth is reported to be good in all areas, with little pest damage. About 400 acres were planted with padi during the off-season in Kedah. Renewed interest in double cropping has been reported from Kelantan, and arrangements were made for a party of cultivators from the Salor padi area to visit Province Wellesley to study growing methods in that region.

An aggregate area of 2,300 acres in the districts of Rembau, Tampin and Seremban (coast) in Negri Sembilan produced no crop last season due to very late planting. A campaign has been launched throughout the State with the object of informing padi-planters of the advantages to be gained by following scheduled planting dates, and 20,000 leaflets with recommendations on suitable planting dates for the 1958/59 season were distributed to padi planters in all districts.

Padi planting was completed in the States of Kedah, Perlis and Penang during the quarter. Elsewhere planting ranged from almost complete to only 60 per cent completed in Johore. The estimated acreage to be planted in the 1958/59 season is 875,500 acres; at the end of December, acreage actually planted was 832,800, or 95.1 per cent of the total acreage to be planted. For the 1957/58 season 850,150 acres were actually planted.

Throughout the Federation droughts of varying intensity hampered land preparation and transplanting of padi in the second and third quarters of the year, and as a result in many areas overage seedlings were planted, while the general standard of land preparation was below average. These factors appear likely to cause a rather smaller padi yield in the 1958/59 season than in the previous season which was an all time record.

The acreage under dry padi this year will show an appreciable increase as compared with last season, particularly in the East Coast States. In Pahang, for example, where extensive areas of jungle have been cleared, the land is being catch-cropped with dry padi and food-crops prior to planting with rubber—at the end of August the area planted under upland dry padi in Pahang amounted to 2,030 acres; only 12 acres were so planted in the previous season. The estimated total area to be planted under upland dry padi this season is 21,750 acres; the total area planted last season amounted to 17,030 acres. Similarly, an increased planted acreage is anticipated for lowland dry padi this season: 39,450 acres is the estimated area to be planted—an increase of over 5,000 acres on last season's planted acreage. By the end of August, 20,630 acres had actually been planted.

Government-financed padi fertilizer subsidy schemes were in operation this season in the States of Kelantan, Trengganu, Negri

Sembilan and Malacca. In Kelantan, where the scheme is in its seventh year, there is a Government subsidy of 90 cents on every 100 lb. bag of padi fertilizer mixture supplied to cultivators by approved agents—the cost to the cultivator being \$10.50 per 100 lb. bag, or \$21 per acre if the fertilizer dressing is applied at the recommended rate of 200 lb. per acre. In Trengganu, the Government subsidy rate for the current season is \$2 per 100 lb. bag, and the cultivator will pay \$19 per acre for fertilizer application at the recommended rate. In Negri Sembilan, the actual cost of fertilizers for padi under the subsidy scheme is \$30 per acre, including price of bags and delivery charges; the individual cultivator will pay \$18.50 per acre, with the balance of \$11.50 met from subsidy scheme funds. The subsidised price for padi fertilizers in the Malacca scheme will be \$20 per acre in the 1958/59 season; actual cost without subsidy is \$26.70.

Rubber

28.8 million clonal seed were purchased from approved sources during the period July—September, and established in nurseries throughout the country to meet smallholders estimated requirements for clonal stumps in the 1959 planting season. The Board of Administrators of the Rubber Industry Smallholders Planting Material Scheme approved the establishment of a further 50 acres of rubber budwood multiplication nurseries, in view of the large increased demand for budwood from smallholders. Work commenced during the quarter to establish a central nursery block of 35 acres at the Federal Experiment Station, Serdang; a further 10 acres will be established in Johore, and 5 acres in Kelantan.

A programme of replanting proportionate acreages of the existing 90-acres of budwood nursery annually has also been initiated.

Distribution of planting materials to rubber smallholders during the third quarter, for both replanting and new planting, from departmental nurseries, amounted to 89,021 yds. of budwood and 1,679,185 clonal seedling stumps. For the fourth quarter the figures are 70,667 yds. of budwood and 6,020,155 clonal seedling stumps.

Despite seasonal variations there is a pronounced long term swing among smallholders away from the use of clonal seedling stumps and towards budgrafting. This swing has resulted in a temporary surplus of clonal seedling stumps, although supplies of budwood have been adequate to meet demand.

Oil Palm

Further co-operative varietal trials have been established on estates in Johore and South Perak. The widespread and severe infestation of bagworm, *Cremastopsyche pendula*, which has been present on an estate in Perak for some years has now abated following aerial spraying with endrin.

In one estate three trials comprising in all 60 acres, were planted. These trials included progeny of various short-trunked types and a genetic collection of five selfed Dumpy progenies derived from a Gunong Melayu (Sumatra) short palm.

Studies on the relationship between oil and moisture content of the mesocarp have been continued.

Coconut

Harvesting of selfed nuts from selected palms at Port Swettenham continued at the rate of about 50 nuts per month. These nuts are intended for planting at Telok Bahru in 1959.

Steady progress was made in the development of the Federal Experiment Station, Telok Bahru, Perak. Small scale planting has been carried out and a 25 acre block under secondary jungle which was felled during the last quarter has been cleared. This area is to be planted with coconut in 1959.

Rhinoceros beetle continues to do damage at the Station despite regular inspection rounds. It has been necessary to contact the managers of estates bordering the Federal Experiment Station with a view to improving their control measures against this pest, as it is felt that the beetle is migrating from the palms on these estates to the Station.

Responses to fertiliser on smallholder land at Batu Rakit, Trengganu, has fallen off this year. Responses are still definite but overall yield has dropped. It is clear that it will be some years before positive results can be expected. Investigations to determine the effect on coconut of Dalapon (the Sodium salt of 2 : 2 Dichloropropionic acid) used for eradication of grass weed have shown that no harmful effect is apparent for treatments at normal and above normal dosage levels. Confirmatory investigation is required but the evidence available suggests that Dalapon at economic rates can be used for grass eradication under coconut palms without harmful effect.

Manurial demonstration plots using organic manures and inorganic fertilizers on *bris* soil in Kelantan, Trengganu and Pahang laid down in 1957, continue to interest smallholders in the localities concerned, and an increase in the number of demonstration plots is being undertaken in Pahang in the coastal area between Pekan and Rompin. It is estimated that the acreage of smallholding coconut land in Kelantan and Trengganu which would be particularly responsive to fertilizer application exceeds 21,000 acres.

There was some recovery of prices of copra and nuts during the third and fourth quarters.

Coffee

Trials to date have shown the outstanding effect on growth and yield of potash and copper on Liberian coffee grown on peat soil at Jalan Kebun. These findings have been followed up by laying down a further trial at that station to investigate optimum manurial and cultural practices necessary to establish and maintain Liberian in good health and high yield on these deep peat soils.

The price at Klang for dried Liberian coffee beans at the end of September was \$165 per pikul. The corresponding price in September

last year was \$142 per pikul. At the end of December, however, the price was \$145 per pikul, a fall of \$20 per pikul over the previous quarter.

Cacao

"Dieback" continues to be severe in almost all planted areas and experiments to determine whether a virus is involved have continued; so far without positive results.

Samples of chocolate prepared from beans dried artificially were found to have a pronounced acidic taste which is not present with sun dried beans.

In a sand culture experiment deficiency symptoms of Zn, Cu, B, Fe, and Mo have been induced. It has not proved possible to obtain symptoms of Mn deficiency by the same method. This would indicate that cacao has a very low requirement for Mn.

There was some improvement in the growth and vigour of cacao at Jerangau in Trengganu during the period. This was a normal seasonal effect associated with dry weather. It has been recommended that no further smallholder planting of cacao should be undertaken in Malaya until such time as the problem of leaf yellowing and dieback is solved.

Pineapple

The first phase of clonal selection of Singapore Spanish and Sarawak pines has been completed and recommendations made for planting a much reduced number of selections of both varieties at Alor Bukit, Johore. The Singapore Spanish/Sarawak hybrid material imported from Taiwan in 1956 has started to fruit. A test canning showed a product superior to that obtained from the Singapore Spanish variety both in colour and flavour.

The overall rejection rate of smallgrowers' fruit in Johore remained at a high level, and abandonment of holdings continued due to the low prevailing price of 2.5 cents per pound for fruit.

The seasonal peak in fruit production began in early December, and the usual crop of difficulties over disposal of fruit began. The cannery in Selangor closed down in August, and has not been in operation subsequently. At the end of December canneries in Singapore and Johore ceased accepting smallgrower fruit for a short period, but were prevailed upon to recommence purchasing. Much fruit was wasted during the interim period.

Fruit

In connection with selection work on rambutan, samples of fruit are being analysed for soluble solids, sugar, acidity and pH. Fruit weights and proportion of flesh, skin and seed in the various varieties are being recorded.

A ten acre field under abandoned oil palm at Federal Experiment Station, Serdang, has been felled and cleared in preparation for the planting in 1959 of a new rambutan clonal trial. Material for this trial

is being propagated. Existing rambutan and durian variety trials flowered profusely during the third quarter.

Importation from Australia of seed of four major citrus root stock species has been successfully carried out during the quarter. The seed has been sown at the Federal Experiment Station, Serdang, and will in due course be used for citrus root stock trials and for the establishment of a seed nursery. A trial consignment of pollen of *Poncirus trifoliata* was received from Australia in late September. If feasible, this pollen is to be used for investigations to determine the percentage apomictic (asexual) seed present in the neck orange *limau chembol* and *C. suhuiensis*, the local Chinese mandarin orange.

The durian variety trial at the Federal Experiment Station, Serdang, came into bearing and was harvested during the last quarter. Yield figures are not yet to hand but a most promising crop was obtained.

Mandarin orange observation blocks have been established at the Federal Experiment Station, Gajah Mati, and the Federal Experiment Station, Jalan Kebun. It is hoped once plants are established at Gajah Mati to superimpose some manurial observations on the block, while the plot at Jalan Kebun is to observe the growth and yielding habits of Mandarin oranges on peat soil.

A total of 8,853 fruit trees were sold from Departmental Stations during the second quarter, and in addition 4,973 plants were distributed by commercial nurseries through the Department. The demand for quality fruit trees, particularly from new land development scheme areas, continues to expand, and in several States arrangements are being made to encourage the expansion and/or establishment of commercial fruit nurseries using clonal material from departmental sources. In Trengganu, mandarin orange planting material is in big demand, and the Department has encouraged reliable growers to produce marcots for sale or distribution.

Pruning demonstrations carried out on rambutan trees after the fruit harvest in December and January, on the holdings of progressive farmers in Kelantan, have aroused interest. Flowering of old and young trees has been profuse and earlier than unpruned trees. More widespread adoption of this practice annually after fruit harvest can be anticipated in future in the *kampong* areas where demonstrations have been carried out.

Water melon is a crop which has gained in popularity in several localities. In East Pahang, the Department has laid down 16 demonstration plots, with the object of encouraging the cultivation of this crop among padi planters and fishermen as a supplementary source of income. Fruit has fetched \$10—\$15 per picul depending on pality.

Tea

The collection of tea clones at the Federal Experiment Station, Serdang, has been maintained and additional material has been planted

out. Experiments at the Federal Experiment Station, Cameron Highlands, have been maintained and a further manurial trial is being designed to follow up the successes of previous manurial trials. Observation plots of tea have been established at the Federal Experiment Stations, Gajah Mati, Jalan Kebun and Jerangau, with the general object of investigating growth and yielding habits under the various conditions at these stations.

Tobacco

There has been increasing interest in the cultivation of this crop in North Pahang, particularly in Jerantut district. Planting is done mostly on new clearings of land intended for rubber. Prices for cured leaf were \$120—\$150 per picul for Grade I, \$80—\$120 per picul for Grade II, and \$40—\$80 per picul for Grade III. In Perak, the mid-year crop acreage planted was about 1,300 acres, and harvesting was in full swing at the end of June. Prices up to \$240 per picul were paid for cured leaf of best quality.

Foodcrops

About 650 acres of off-season maize has been planted in the Trans-Perak River Irrigation Area; this is an encouraging response resulting from a visit to the Chui Chak area arranged previously by the Department for a group of cultivators from Trans-Perak. Off-season cropping on the normal extensive scale was undertaken by padi cultivators at Chui Chak in Perak, Sekinjang in Selangor, and in Malacca Central.

Pastures, Fodders and Livestock

Brachiaria brizantha is proving to be a promising pasture grass. It is compact in growth, stands grazing well and resists weed invasion.

A pig feeding trial being conducted at the Federal Experiment Station, Serdang, is now in its eleventh replication. Results to date suggest that the Lehman system of feeding suitably modified for local conditions is proving better than the standard Serdang system. The modified Lehman system is based on feeding concentrate up to 50 lb. live weight and thereafter maintaining the same level of concentrate but providing bulk foods produced locally to satisfy appetite.

A trial designed to investigate the growth rate and food intake of Bali cattle and to explore the economics of fattening these cattle by stall feeding with cut fodder has continued at the Federal Experiment Station, Serdang. Castrated animals fed on Guinea grass plus protein cake have averaged a liveweight increase of over one pound per day whereas castrates fed on Guinea grass alone have only averaged a liveweight increase of about half a pound per day.

Soil Surveys

Reconnaissance soil survey field work was continued in the Padang Terap, Kota Star and Kubang Pasu districts of North Kedah, and short

road reconnaissance were made in the Baling district and along the Kulim-Serdang-Selama road. At the same time work on the compilation of the draft schematic soil map of the State has been commenced, and the pattern of soil distribution in Kedah is now becoming more apparent. As a result of the field work a number of new soil series have been set up, and the distribution of these series is now being mapped on an association basis. Survey work has so far been concentrated in North Kedah, where the soils of the Padang Terap area have been found to be of much below average fertility, while the best soils located so far have been in the Kubang Pasu district.

Detailed soil surveys were also carried out in the Weng Valley, beyond Baling, (2,500 acres); along the Naka-Nami road (5,000 acres); and in the Sungkap Forest Reserve (1,200 acres), the latter two areas have been selected as possible sites for Land Development Schemes.

Reconnaissance soil survey field work, which was discontinued before last year's monsoon, was recommenced in Ulu Kelantan. The results of this trip were disappointing, as most areas which appeared from the existing air reconnaissance maps, or aerial photographs, to be reasonably flat and low-lying proved to be considerably more broken and steeply sloping than had been expected. When developed over more gently undulating country, the soils in this region are generally quite good, and the chief factor limiting agricultural development is the steep slopes (25 to 30°) even in areas with maximum elevation less than 400 feet.

A detailed-reconnaissance soil survey of the Labu, Jimah, and Sendayan Forest Reserves, Negri Sembilan, covering an area of about 17,000 acres was made during the month of July. Except for the steeply sloping hills, which cover about a quarter of the area, the soils were found to be suitable for rubber and *dusun* (orchard).

In Negri Sembilan, Stage II of the Sungei Raya Scheme is intended for development under permanent dry land crops. Complete drainage works have been constructed and although it is anticipated that some difficulty may arise due to the very acid sub-soil, adequate drainage and manuring should ensure satisfactory growth of coconuts and coffee.

A detailed-reconnaissance soil survey has been made of the 14,000 acre Sg. Bilut Land Development Scheme area, Pahang. Some 9,800 acres of the area were considered suitable for cultivation with rubber or *dusun*, while a further 1,100 acres was considered suitable for wet padi. A group of poor soils occurring in the centre of the area was not recommended for cultivation.

A start was made with the soil survey of a 5,000 acre block of land bordering the Maran-Temerloh road, which has been selected as a possible site for a Land Development Scheme, and this survey is still continuing.

An examination of two proposed sites for oil palm cultivation was carried out near Kulai, Johore. One area, covering about 2,000 acres, was found to consist of soil of mediocre fertility while the other area,

consisting of about 4,000 acres containing soils of above average fertility was recommended as being the more suitable site. This latter area is believed to be bordered on three sides by jungle-covered areas of similar soils which could be used for future expansion of the scheme.

A reconnaissance was also made of about 2,000 acres proposed for development near Endau.

Survey of stages II and III of the Juru-Jajawi, Province Wellesley, Drainage Scheme was started and is nearing completion. Some 4,000 soil samples have been taken. These are being examined visually in an attempt to classify the soils into series or groups.

Studies on phosphate extraction by various extractants have been carried out on soils developed on a range of parent materials under virgin jungle in Kedah. At the same time a pot experiment is being undertaken in order to correlate plant growth and phosphate uptake with the amount of phosphate extracted from the various soils by the different extractants under test.

Pests and Diseases

A new host record for *Helminthosporium* sp was observed for the first time on *Teersia hexandra*. This grass is common in all padi areas and it is suspected that brown leaf spot of padi is caused by the same fungus.

A case of stem bleeding of coconuts was reported from Perak. *Ceratostomella paradoxa* is reported in other countries to cause stem bleeding but this particular fungus could not be isolated in this case.

Samples of caterpillars attacking leaves of rambutan were identified as *Stauropus alternus*.

Education

To date, four kampong Agricultural Committees have been formed in Kelantan, wherein a committee of progressive farmers sets out to encourage other farmers in the locality to improve their holdings and so their economy. At Bachok Agricultural Station a hostel, the construction of which is being financed by smallholders as a result of a proposal by the Telong Agricultural Committee, is being erected in order that interested farmers may participate in instructional courses at the Station.

In all States Rural Training Centres continued to function and 530 persons were given training of from 11 days to 10 weeks duration, during the fourth quarter.

STAFF NOTES

(Period 1st October to 31st December, 1958)

Appointments

<i>Name</i>	<i>Appointment</i>	<i>Date</i>
Aw-Yong Kong Keong	Pupil Agronomist (Posted as Agronomist, North-West)	4.11.58

Promotions

The following promotions have been approved:—

<i>Name and Rank</i>	<i>Promoted to</i>	<i>Date</i>
Haji Abu Hassan bin Sidong, Agricultural Assistant	Assistant Lecturer	15. 8.57
Abu Bakar bin Mohd. Tahir, Agricultural Assistant	Assistant Lecturer	15. 8.57
Tamin bin Hussain, Agricultural Asst.	Assistant Lecturer	15. 8.57
J. K. Coulter, Senior Research Officer, Grade 'A'	Assistant Director (Research)	1. 1.58
F. B. Brown, Senior Research Officer, Grade 'B'	Senior Research Officer, Grade 'A'	1. 1.58
A. R. McWalter, Research Officer	Senior Research Officer, Grade 'B'	1. 1.58
Tak bin Haji Daud, Asst. Research Officer	Agricultural Development Officer	1. 1.58
Sulan bin Salleh, Agricultural Asst.	Assistant Research Officer	1. 1.58
B. Rengaswamy, Agricultural Asst.	Assistant Agricultural Officer	1. 1.58
P. G. Coleman, Senior Agricultural Officer, Grade 'A'	Deputy Director of Agriculture	1. 3.53
A. L. Barcroft, Senior Agricultural Officer, Grade 'A'	Assistant Director of Agriculture, (Field)	29. 3.58
Chew Hong Jung, Senior Lecturer	Principal, College of Agriculture	10. 6.58
C. Whitehead, Agronomist	Senior Agronomist	18. 7.58
F. N. G. Conaty, Senior Research Officer, Grade 'B'	Senior Research Officer, Grade 'A'	25. 9.58

Postings

The following postings have been made:—

<i>Name</i>	<i>Posted as</i>	<i>Date</i>
Mohamad bin Jamil	 Senior Agricultural Officer, (Headquarters) (Ag. Senior Agricultural Officer, Grade B)	3.11.58
G. S. Keeping	 Assistant Director (Field) (Acting)	1.12.58
A. R. McWalter	 Senior Soils Chemist (Acting Senior Research Officer, Grade A)	6.12.58
A. V. Haddon	 Senior Botanist (Acting Senior Research Officer, Grade B)	6.12.58
Yap Sin Hee	 Administrative Officer (Acting)	20.11.58
K. Nagapen	 Executive Officer	20.11.58

Retirements

The following officers proceeded on leave prior to retirement under the Tenth Schedule to the Federation of Malaya Agreement (Amendment No. 4) Ordinance, 1956:—

<i>Name and Rank</i>	<i>Date</i>
H. F. Logan	 Administrative Officer 19.11.58
F. B. Brown	 Senior Botanist 5.12.58 (Senior Research Officer Grade A)

Leave

The following officers returned from leave:—

<i>Name and Rank</i>	<i>Date</i>
G. S. Keeping	 Assistant Director (Field) 16.11.58 (Acting)
J. K. Coulter	 Assistant Director (Research) 25.11.58

Note: on Retiring Officers

Mr. F. B. BROWN

Yet another recent retirement under the provisions of the Malayanisation scheme is that of Mr. F.B. Brown, who left the Department on 15th December, 1958.

Mr. Brown was one of the many people who had their academic careers interrupted by World War II, for he joined Bristol University in 1938 but entered the Somerset Light Infantry soon after the outbreak of war in 1939. On being commissioned he was transferred to the Indian Army where he had his first experience of the tropics. After demobilisation he returned to Bristol University in 1946 and on graduating from there proceeded to Cambridge to specialise in plant breeding, eventually arriving in Malaya in July, 1951.

On joining the Department Mr. Brown started the initial work on pineapple selection and he succeeded in building up a comprehensive collection at the Federal Experiment Station, Jalan Kebun, Selangor. This collection forms the basis for all the present botanical work on pineapple.

With the reorganisation of the Division, Mr. Brown transferred his attention to padi selection and breeding, a project in which he made very considerable progress over the past few years. He succeeded in completing a number of varietal selection programmes which had been in progress for some years and the performance of these varieties in field trials has been very promising. The work, together with that on natural cross pollination and hybrid vigour of rice, form permanent records of his success as a plant breeder.

Mr. Brown was a keen follower of sport, particularly cricket, and Test Match prospects always provoked lively discussions with him. He also took a keen interest in staff matters being, for some considerable period, a member of Whitley Council.

Mr. Brown's wide experience of rice research will not be lost to tropical agriculture for he has taken up a post with the Food and Agricultural Organisation and has been posted to a rice research project in Venezuela.

To him and Mrs. Brown, an active participant in the Girl Guide movement, we wish every success in whatever sphere their interests may take them in the future.

STATISTICS

July to September, 1958

Rubber.—The price of rubber, as quoted by the Singapore Chamber of Commerce Rubber Association, improved by nearly six cents per pound over the previous quarter. International Type 1 (R.S.S.1) averaged 79.75, 81.43 and 82.40 cents per pound f.o.b. for July, August, and September.

The price movement reflected increased interest by Russia and the United States of America, but inventories in America were still being maintained at rather low levels. The reluctance of manufacturers to hold adequate stocks is a factor in price instability, and should a shortage of natural rubber develop, would force manufacturers to turn to synthetic for their requirements. At present the ratio of consumption between natural and synthetic rubber substitutes remains fairly steady.

Of the new rubber consumed in the United States in September, 36.37 per cent was natural. In Britain the corresponding figure was 74 per cent.

Copra.—The market remained strong over the period and the upward trend of prices continued. On average, a gain of one dollar was recorded per pikul of copra over the previous quarter, the price being fairly steady at around \$33 per pikul.

Palm Oil.—The average price per ton of palm oil fell to £69.5.0 during August and to £66.16.0 during September. These are the lowest prices so far recorded in 1958, the highest being £80.7.0 per ton in March.

Table I

AVERAGE MONTHLY PRICES PAID BY LOCAL DEALERS FOR SMALLHOLDERS' RUBBER, JULY TO SEPTEMBER, 1958

(dollars per pikul*)

Grades	Alor Star, Kedah			Seremban, Negri Sembilan			Johore Bahru, Johore		
	July	Aug.	Sept.	July	Aug.	Sept.	July	Aug.	Sept.
Smoked Sheet No. 1	92.36	93.97	94.95	92.13	93.35	94.62	92.14	93.35	94.43
Smoked Sheet No. 3	79.99	84.47	86.47	81.64	85.62	88.01	82.11	86.03	88.19

* 1 pikul = 133½ lb.

This table has been compiled from statistics supplied by the Chief Statistician, Federation of Malaya.

Table II
RUBBER PRODUCTION
FEDERATION OF MALAYA
(long tons, dry weight)

MONTH	ESTATES		SMALLHOLDINGS (ESTIMATED)		TOTAL	
	1957	1958	1957	1958	1957	1958
January -	36,070	35,800	27,184	25,400	63,260	61,200
February -	27,002	28,800	21,998	22,900	49,000	51,700
March -	25,908	28,400	20,915	20,300	46,823	48,700
April -	26,501	26,600	22,460	18,200	48,961	44,800
May -	27,129	27,200	18,305	18,100	45,434	45,300
June -	29,628	31,200	21,583	21,800	51,211	53,000
July -	32,405	36,500	24,054	23,700	57,459	60,200
August -	32,957	34,000	23,119	24,600	56,076	58,600
September -	31,418	33,700	21,374	23,500	52,792	57,200
October -	33,290	35,000	22,462	23,000	55,752	58,500
November -	34,369		22,594		56,963	
December -	32,390		21,976		54,366	
Total -	369,073		268,024		637,097	
Total 1956 -	352,233		273,368		625,601	

This table has been compiled from statistics published by the Chief Statistician, Federation of Malaya.

Production on smallholdings (estates of less than 100 acres) is taken as the total of purchases from smallholders reported by licensed dealers.

Table III
AVERAGE PRICES PAID IN LONDON FOR TEA
(s.d. per lb.)

For the Week Ending	Malayan		Ceylon		Indonesian		India				Africa	
							Northern		Southern			
	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.
5. 9.58	3	8.14	4	4.78	3	3.26	6	9.44	3	7.77	3	3.97
12. 9.58	3	9.10	4	5.22	4	2.91	6	7.79	3	7.61	3	3.54
19. 9.58	4	0.05	4	8.31		Nil	6	4.36	3	7.65	3	2.75
26. 9.58	3	11.17	5	2.37	3	10.00	6	0.60	3	8.71	3	2.10
3.10.58	3	9.24	5	5.21	2	10.30	6	1.04	3	8.72	3	4.64
10.10.58	4	5.55	5	5.28		Nil	5	6.20	3	8.65	3	4.32
17.10.58	3	2.74	5	1.65		Nil	5	1.35	3	6.85	3	1.94
24.10.58	3	5.30	5	1.35		Nil	4	9.38	3	6.66	2	11.48
31.10.58	3	8.28	4	9.82		Nil	4	10.64	3	5.31	3	1.67
7.11.58	3	7.58	4	8.77	2	9.32	4	10.31	3	5.17	2	10.56
14.11.58	3	11.81	4	8.17	2	8.53	4	8.56	3	4.54	3	2.60
21.11.58	3	5.50	4	8.06	2	10.62	4	7.15	3	5.97	2	11.19
28.11.58	5	2.37	4	9.44		Nil	4	6.65	3	6.17	3	1.82
5.12.58	4	2.53	4	10.36		Nil	4	6.19	3	5.57	3	4.50
12.12.58	4	3.15	4	10.99		Nil	4	5.82	3	5.20	3	2.68
19.12.58	3	5.78	4	11.84		Nil	4	4.98	3	7.02	3	3.68

Table IV

**AVERAGE DEALERS' PRICES FOR DRIED LIBERIAN
COFFEE BEANS GROWN IN SELANGOR***

(dollars per pikul †)

For the Week Ending	Klang	Kuala Langat
	£	£
11-10-58	165.00	163.00
18-10-58	165.00	165.00
25-10-58	160.00	158.00
1-11-58	160.00	159.00
8-11-58	162.00	159.00
15-11-58	158.00	158.00
22-11-58	153.00	155.00
29-11-58	150.00	150.00
6-12-58	150.00	147.00
13-12-58	148.00	146.00
20-12-58	145.00	145.00
27-12-58	145.00	145.00

* These are not the prices paid to smallholders, who sell freshly harvested berries to dealers for processing.

† 1 pikul = 133½ lb.

Table V

PRODUCTION OF PALM OIL AND KERNELS AND PRICES OF PALM OIL

(long tons, as declared by estates)

Month	Production of Palm Oil (long tons)		Production of Palm Kernels (long tons)		Average Price per Ton of Palm Oil *		
	1957	1958	1957	1958	1958		
January -	3,527	3,581	921	981	£	s.	d.
February -	3,572	4,460	926	1,192	77	14	0
March -	4,828	6,090	1,225	1,645	78	2	0
April -	4,585	5,748	1,168	1,552	80	7	0
May -	4,689	5,609	1,096	1,408	78	14	0
June -	5,140	5,782	1,203	1,398	78	17	0
July -	5,823	7,243	1,480	1,874	74	15	0
August -	5,355	6,939	1,445	1,832	72	10	0
September -	5,666	6,952	1,408	1,800	69	5	0
October -	5,896	5,825	1,465	1,523	66	16	0
November -	5,070		1,341		68	1	0
December -	5,356		1,103				
Total -	58,507		14,781				

* F.O.B.

Table VI
PRODUCTION OF COPRA, COCONUT OIL AND COPRA CAKE
FEDERATION OF MALAYA
 (tons)

MONTH	COPRA PRODUCTION					COCONUT OIL PRODUCTION *		COPRA CAKE (POONAC) MANUFACTURED	
	Estates		Smallholdings (estimated)		Total	Oil Mills		Oil Mills	
	1957	1958	1957	1958	1957	1957	1958	1957	1958
January	2,473	2,449	8,454	1,857	10,927	8,272	8,164	5,160	5,136
February	2,339	2,546	5,916	8,100	8,255	7,919	5,458	4,803	3,397
March	2,725	2,895	5,510	7,028	8,235	8,677	7,032	5,340	4,469
April	2,848	2,910	6,975	8,421	9,824	6,618	6,032	4,245	3,905
May	3,098	3,275	8,185	11,123	11,283	6,614	7,223	4,163	4,690
June	3,513	3,431	7,235	3,447	10,748	8,541	7,485	5,405	4,886
July	4,105	3,985	10,456	8,372	14,561	8,879	7,828	5,649	5,183
August	3,488	3,575	10,865	9,200	12,557	8,775	7,168	5,528	4,669
September	3,195	2,769	7,948	5,400	11,143	8,704	7,168	5,470	4,620
October	2,880	2,519	9,385	6,000	12,815	9,174	6,939	5,753	4,472
November	2,591		5,285		7,876	8,347		5,231	
December	2,587		7,671		10,258	5,988		3,941	
Total	35,843		94,435		130,278	96,508		60,688	

Notes:—1. The above table has been compiled from statistics published by the Chief Statistician, Federation of Malaya.

2. Estate copra production and coconut oil production are as declared by estates and oil mills, respectively.

3. Statistics of smallholding coconut oil production are not available.

4. Smallholding copra production for commercial purposes is estimated from the formula: imports + estate stocks (opening) + estate production + smallholding production = exports + local oil mill consumption + estate stocks (closing).

* Includes: both refined and crude oil.

Table VII
SINGAPORE PRICES OF VARIOUS AGRICULTURAL PRODUCTS
(dollars per pikul †)

Date	Copra, Sundried	Coconut Oil *	Pepper, F.A.Q. Muntok White	Pepper, Gen. Muntok White	Gambier, Cube	Sago Flour, Lingga	Tapioca Flour No. 1	Oilcake, Round
11- 8-58	32.75	52.00	132.00	142.00	48.00	9.37	18.00	12.00
18- 8-58	32.75	50.00	127.00	137.00	48.00	—	18.00	12.75
25- 8-58	33.00	52.50	126.50	136.50	48.00	—	18.00	12.50
1- 9-58	33.50	52.75	127.00	137.00	48.00	9.50	18.00	12.50
8- 9-58	33.25	53.50	127.50	137.50	48.00	9.50	18.00	12.50
15- 9-58	33.62	54.50	126.00	136.00	47.00	9.50	18.00	12.50
22- 9-58	35.00	56.50	122.00	132.00	48.00	9.50	18.00	13.50
29- 9-58	34.50	56.00	123.00	133.00	48.00	9.50	18.00	14.00
6-10-58	34.75	56.25	122.00	132.00	48.00	9.50	18.00	14.50
13-10-58	36.50	57.75	124.00	134.00	45.00	9.50	18.00	15.00
20-10-58	37.00	58.25	122.00	132.00	47.00	9.50	17.00	15.50
27-10-58	37.50	60.50	123.00	133.00	45.00	9.50	17.00	15.50
3-11-58	37.50	60.50	124.00	134.00	45.00	9.50	17.00	15.75
17-11-58	40.75	67.00	130.00	140.00	45.00	9.50	18.00	15.75
24-11-58	41.50	66.50	129.00	139.00	45.00	9.50	18.00	16.50
1-12-58	40.75	66.00	131.00	141.00	42.00	9.75	18.00	16.00
8-12-58	41.50	66.00	130.00	140.00	45.00	9.75	18.00	16.50
15-12-58	41.25	64.00	125.00	135.00	48.00	9.75	17.00	16.50
22-1-58	39.50	63.50	128.00	138.50	48.00	9.75	17.50	17.50

† 1 pikul = 133½ lb.

* F.O.B. in second-hand drums.

† Nominal.

The above prices are taken from the weekly reports of the Singapore Chamber of Commerce.

Table VIII
MALAYAN AGRICULTURAL EXPORTS,
JANUARY TO DECEMBER, 1957

Product	NET EXPORTS IN TONS		
	Year 1955	Year 1956	Year 1957
Arecanuts	13,679	11,228	9,625
Coconuts, fresh †	72,140	34,779	37,466
Coconut oil	91,176	103,132	100,031
Copra	75,076 *	82,549 *	71,718 *
Copra cake	56,404 *	66,174 *	73,208 *
Gambier, all kinds	66	96	3
Palm Oil	52,832	55,252	56,728
Pineapples, canned	27,756	30,377	37,671
Sago, flour	23,053	21,483	19,581
Sago, pearl	5,483	4,276	4,021
Sago, raw	18,709 *	18,522 *	14,006 *
Tapioca, flake	475	260	403
Tapioca, flour	3,979 *	3,753 *	1,573 *
Tapioca, pearl	5,470	5,630	5,222

† hundreds.

* net imports.

FEDERATION OF MALAYA RICE STATISTICS

Summary of Acreages and Production, 1957/58 Season

WET PADI

State or Settlement (1)	Area Planted (2)		Area Destroyed (3)		Area Harvested (4)		Average Yield per Acre			Production			Remarks (9)
	acres	per cent of total	acres	per cent of (2)	acres	per cent of (2)	Padi (5)	per cent of main season average yield	Rice (6)	Padi (7)	per cent of total	Rice (8)	
							<i>gantangs</i>		lb.	<i>gantangs</i> (000s)		tons	
Perlis	58,190	6.9	60	0.1	58,130	99.9	374	104.5	1,319	21,764	7.2	34,270	60 acres totally damaged by floods.
Kedah	281,810	33.1	460	0.2	281,350	99.8	397	110.9	1,401	111,783	37.0	176,040	460 acres totally damaged by floods, rats, wild pigs, stem borers.
Kelantan	156,100	18.4	880	0.6	155,220	99.4	332	92.7	1,171	51,496	17.2	81,100	880 acres totally damaged by floods, rats, wild pigs and late planting.
Trengganu	44,620	5.2	280	0.6	44,340	99.4	254	70.9	896	11,276	3.7	17,760	280 acres damaged by floods and pest mainly in Besut District.
Penang and P. Wellesley	39,040	4.6	—	—	39,040	100	413	115.4	1,457	16,130	5.3	25,400	—
Perak	113,280	13.3	120	0.1	113,160	99.9	319	89.1	1,125	36,112	12.0	56,870	100 acres damaged by Penyakit Merah. 20 acres abandoned due to flood.
Selangor	48,510	5.7	150	0.3	48,360	99.7	432	120.7	1,524	20,873	6.9	32,870	150 acres damaged by floods.
Pahang	38,770	4.6	1,870	4.8	36,900	95.2	205	57.3	723	7,577	2.5	11,930	1,870 acres damaged by floods mainly in Pekan District.
N. Sembilan	31,000	3.6	2,330	7.5	28,670	92.5	339	94.7	1,196	9,733	3.2	15,330	2,330 acres could not be harvested due to empty grains because of late planting.
Malacca	30,340	3.6	890	2.9	29,450	97.1	423	118.2	1,492	12,454	4.1	19,610	310 acres destroyed due to shortage of water, 160 acres destroyed due to floods. 260 acres empty grain. 160 acres damaged by pests.
Johore	8,510	1.0	160	1.8	8,350	98.2	324	90.5	1,143	2,710	0.9	4,270	Rat damage 5 acres, bird damage 15 acres, flooding 5 acres, shortage of water and bird damage 135 acres.
Total 1957/58 Main Crop	850,170	100	7,200	0.8	842,970	99.2	358	—	1,263	301,908	100	475,450	—
Off-Season Crop, 1957	7,290	—	60	0.8	7,230	99.2	373	—	1,316	2,697	—	4,250	60 acres destroyed by birds and rats.
Total 1957/58 Main and Off- Season Crops	857,460	—	7,260	0.8	850,200	99.2	358	—	1,263	304,605	—	479,700	—
Total 1956/57 Main and Off- Season Crops	841,390	—	7,130	0.8	834,260	99.2	358	—	—	298,439	—	469,980	—

Acreage to nearest 10 acres.

Rice production to nearest 10 tons.

Conversion rates 635 *gantangs* padi = 1 ton rice.

1 *gantang* padi = 5.6 lb. padi.

1 *gantang* padi = 3.528 lb. rice (i.e. milling recovery of 63 per cent).

FEDERATION OF MALAYA RICE STATISTICS

Summary of Acreages and Production, 1957/58 Season

DRY PADI (LOWLAND)

State or Settlement (1)	Area Planted (2)		Area Destroyed (3)		Area Harvested (4)		Average Yield per Acre			Production			Remarks (9)
	acres	per cent of total	acres	per cent of (2)	acres	per cent of (2)	Padi (5)	per cent of main season average yield	Rice (6)	Padi (7)	per cent of total guntangs (000s)	Rice (8) tons	
							guntangs	lb.	guntangs	tons			
Perlis	—	—	—	—	—	—	—	—	—	—	—	—	25 acres not harvested due to late planting, 25 acres not harvested due to rat damage. 40 acres destroyed by birds, rats etc.
Kedah	1,780	5.2	—	—	1,780	100	242	132.9	854	430	6.9	680	
Kelantan	22,450	66.0	50	0.3	22,400	99.7	183	100.5	646	3,918	63.3	6,170	
Trengganu	7,720	22.6	40	0.5	7,680	99.5	175	96.2	617	1,346	21.7	2,120	
Penang and P. Wellesley	100	0.3	—	—	100	100	314	172.5	1,108	31	0.5	50	
Perak	730	2.1	—	—	730	100	222	121.9	783	163	2.6	260	
Selangor	—	—	—	—	—	—	—	—	—	—	—	—	
Pahang	1,300	3.8	—	—	1,300	100	230	126.4	811	307	5.0	480	
N. Sembilan	—	—	—	—	—	—	—	—	—	—	—	—	
Malacca	—	—	—	—	—	—	—	—	—	—	—	—	
Johore	10	—	—	—	10	100	70	38.5	247	(.42)	—	—	
Total, Main Crop	34,090	100	90	0.3	34,000	99.7	182	—	642	6,195	100	9,760	
Off-Season Crop, 1957	—	—	—	—	—	—	—	—	—	—	—	—	
Total, 1957/58 Main and Off-Season Crops	34,090	—	90	0.3	34,000	99.7	182	—	642	6,195	100	9,760	
Total, 1956/57 Main and Off-Season Crops	41,790	—	530	—	41,260	98.7	186	—	656	7,662	—	12,070	

Acreage to nearest 10 acres.

Rice production to nearest 10 tons.

Conversion rates 635 guntangs padi = 1 ton rice.

1 guntang padi = 5.6 lb. padi.

1 guntang padi = 3.528 lb. rice (i.e. milling recovery of 63 per cent).

FEDERATION OF MALAYA RICE STATISTICS

Summary of Acreages and Production, 1957/58 Season

DRY PADI (UPLAND)

State or Settlement (1)	Area Planted (2)		Area Destroyed (3)		Area Harvested (4)		Average Yield per Acre			Production			Remarks (9)
	acres	per cent of total	acres	per cent of (2)	acres	per cent of (2)	Padi (5) gantas (‘000s)	per cent of main season average yield	Rice (6) lb.	Padi (7) gantas (‘000s)	per cent of total	Rice (8) tons	
Perlis Kedah Kelantan	200	1.2	—	—	200	100	280	123.9	988	54	1.5	90	250 acres not harvested due to floods and rats, 50 acres not harvested due to damage by pigs and elephant. 30 acres destroyed by pests in Dungun.
	2,980	17.5	—	—	2,980	100	175	77.4	617	546	14.4	860	
	7,500	44.0	300	4.0	7,200	96.0	305	134.9	1,076	2,196	57.7	3,460	
Trengganu Penang and P. Wellesley	3,680	21.6	30	0.8	3,650	99.2	158	69.9	557	576	15.2	910	
Perak Selangor Pahang N. Sembilan Malacca Johore	2,670 10 — — —	15.7 — — — —	— — — — —	— — — — —	2,670 10 — — —	100 — — — —	164 8 — — —	72.6 3.5 — — —	579 28 — — —	428 — — — —	11.5 — — — —	670 — — — —	
Total, Main Crop	17,040	100	330	4.8	16,710	—	226	—	797	3,800	100	5,990	
Off-Season Crop, 1957	—	—	—	—	—	—	—	—	—	—	—	—	
Total, 1957/58 Main and Off-Season Crops	17,040	—	300	—	16,710	—	226	—	797	3,800	—	5,990	
Total, 1956/57 Main and Off-Season Crops	13,330	—	300	2.3	13,030	97.7	269	—	949	3,507	—	5,530	

Acreage to nearest 10 acres.

Rice production to nearest 10 tons.

Conversion rates 635 gantas padi = 1 ton rice.

1 gantang padi = 5.6 lb. padi.

1 gantang padi = 3,528 lb. rice (i.e. milling recovery of 63 per cent).

FEDERATION OF MALAYA RICE STATISTICS

Summary of Acreages and Production, 1957/58 Season

TOTAL WET AND DRY PADI

State or Settlement (1)	Area Planted (2)		Area Destroyed (3)		Area Harvested (4)		Production (5)		Rice (6)	
	acres	per cent of total	acres	per cent of (2)	acres	per cent of (2)	Padi (5) gantang ('000s)	per cent of total	tons	
Perlis	53,390	6.6	60	0.1	58,330	99.9	21,818	7.0	34,360	
Kedah	286,570	31.9	460	0.2	286,110	99.8	112,759	36.1	177,580	
Kelantan	186,050	20.6	1,230	0.7	184,820	99.3	57,610	18.5	90,730	
Trengganu	56,020	6.2	350	0.6	55,670	99.4	13,198	4.2	20,790	
Penang and Province Wellesley	39,140	4.3	—	—	39,140	100	16,161	5.2	25,450	
Perak	116,680	12.9	120	0.1	116,560	99.9	36,703	11.8	57,800	
Selangor	48,510	5.4	150	0.3	48,360	99.7	20,873	6.7	32,870	
Pahang	40,080	4.4	1,870	4.7	38,210	95.3	7,884	2.5	12,410	
Negri Sembilan	31,000	3.4	2,330	7.5	28,670	92.5	9,733	3.1	15,330	
Malacca	30,340	3.4	890	2.9	29,450	97.1	12,454	4.0	19,610	
Johore	8,520	0.9	160	2.0	8,360	98.2	2,710	0.9	4,270	
Total, Main Crop	901,300	—	7,620	0.8	893,680	99.2	311,903	—	491,200	
Off-Season Crops, 1957	7,990	—	60	0.8	7,230	99.2	2,697	—	4,250	
Total, 1957/1958 Main and Off-Season Crops	908,590	—	7,680	0.8	900,910	99.2	314,600	—	495,450	
Total, 1956/1957 Main and Off-	896,510	—	7,960	0.9	888,550	99.1	309,608	—	487,570	

Acreage to nearest 10 acres.

Rice production to nearest 10 tons.

Conversion rates 635 gantangs padi = 1 ton rice.

1 gantang padi = 5.6 lb. padi.

1 gantang padi = 3.528 lb. rice (i.e. milling recovery of 63 per cent).

METEOROLOGICAL SUMMARY, MALAYA, AUGUST, 1958

Locality	Air Temperature Degrees Fahrenheit						Earth Temperature			Rainfall						Bright Sunshine			
	Means of			Absolute Extremes			At 4	At 1	Number of Days			Most in a day		Total				Total	Daily Mean
	A.	B.	Max.	Min.	Max.	Min.	foot	feet											
					Highest	Lowest	Min.	Max.	of	o F.	Precipitation .01 in or more	Thunderstorm	Fog morning obs.	Gale force 8 or more		Per cent.			
Ipoh, Perak	92.2	93.5	82.9	94.2	71.1	88.2	75.9			7.85	119.4	1.74	16	15	1	209.50	6.76		
Kuala Lumpur, Selangor	90.7	73.1	81.9	94.1	70.9	86.5	76.1			8.82	22.40	2.39	14	11	8	201.75	6.51		
Sitiawan, Perak	90.1	73.5	81.8	92.2	70.1	82.7	75.6	85.3	86.7	5.08	129.0	1.34	10	9	5	200.10	6.45		
Kuantan, Pahang	89.0	72.5	80.7	93.1	70.4	79.0	76.0	83.5		9.86	250.4	2.10	22	21	12	163.80	5.28		
Bayan Lepas, Penang	87.0	74.3	80.7	90.1	71.4	82.8	76.8			8.41	213.6	1.69	17	12	2	165.00	5.32		
Malacca	87.1	73.1	80.1	91.0	71.0	80.5	75.0			9.88	251.0	3.05	16	13	2	174.60	5.63		
Mersing, Johore	88.3	71.9	80.1	91.4	70.2	80.5	73.6			6.46	164.1	2.82	14	12		155.40	5.01		
Alor Star, Kedah	88.8	74.2	81.5	93.8	70.8	84.2	77.3			7.57	192.3	1.63	21	16	2	180.45	5.82		
Kota Bharu, Kelantan	88.3	74.3	81.3	91.8	72.4	83.0	76.8	85.7	87.1	9.99	253.7	2.05	15	14	8	192.65	6.21		
K. Trengganu, Trengganu	87.9	73.5	80.7	91.0	71.1	79.9	76.0			6.08	154.4	2.06	13	13	1	168.65	5.44		
Singapore	86.9	72.2	79.5	91.7	71.6	82.2	77.7			11.05	280.7	2.61	14	14	4	118.70	3.83		
HILL STATIONS																			
Cameron Highlands, Tanah Rata, Pahang. (3750 ft.)	72.8	55.6	64.2	76.0	51.5	70.0	62.5			6.65	168.9	1.24	23	19		124.90	4.03		

Compiled from returns supplied by the Malayan Meteorological Service.

METEOROLOGICAL SUMMARY, MALAYA, SEPTEMBER, 1958

Locality	Air Temperature Degrees Fahrenheit							Earth Temperature			Rainfall						Bright Sunshine		Per cent.		
	Means of			Absolute Extremes				At 1	At 4	Total	Most in a day	Number of Days					Total	Daily Mean			
	A.	B.	Min.	Max.	Lowest	Min.	Lowest					Max.	Highest	Precipitation .01 in. or more	Precipitation .04 in. or more	Thunderstorm				Fog morning obs.	Gale force 8 or more
Ipo, Perak	92.5	73.5	83.0	96.8	69.9	87.0	76.9			in. 3.93	mm. 9.98	in. 15	11	3		1	hr. 176.90	5.90			
Kuala Lumpur, Selangor	91.1	73.2	82.1	95.2	71.8	86.9	75.1			3.52	89.4	1.23	14	3	1		174.05	5.80			
Sitiawan, Perak	90.9	72.8	81.4	93.6	69.3	86.0	76.2	85.4	86.7	6.32	160.5	1.45	18	9	1		176.55	5.89			
Kuantan, Pahang	89.1	72.4	81.1	93.6	69.7	84.5	76.5	83.5		8.13	206.5	1.65	14	11	1		178.60	5.95			
Bayan Lepas, Penang	87.3	74.8	81.1	90.0	72.2	83.0	77.6			9.46	240.3	1.60	21	16	7		180.60	6.02			
Malacca	87.7	73.5	80.6	89.8	71.7	84.9	75.9			11.48	291.6	3.32	19	14		1	167.85	5.39			
Mersing, Johore	89.1	71.7	80.4	92.4	70.0	83.7	75.1			7.43	188.7	1.58	17	16	1		184.85	6.16			
Alor Star, Kedah	87.9	74.6	81.3	90.9	72.6	80.6	77.3			9.26	235.2	1.88	19	16	1		188.25	6.27			
Kota Bharu, Kelantan	88.4	74.3	81.3	91.7	72.0	83.6	77.6	85.7	86.9	5.24	133.1	2.51	16	12	8	2	186.50	6.22			
K. Trengganu, Trengganu	88.3	73.9	81.6	91.2	71.2	82.6	76.0			6.36	161.5	1.85	14	11			169.35	5.65			
Singapore	86.6	75.2	81.9	91.5	72.8	82.7	78.9			1.56	39.6	0.69	13	9	9		159.15	5.31			
HILL STATION																					
Cameron Highlands, Tanah Rata, Pahang. (4750 ft.)	73.5	52.8	63.1	76.0	41.8	70.4	52.2			5.83	148.1	1.50	18	17			107.40	3.58			

Compiled from returns supplied by the Malayan Meteorological Service.

METEOROLOGICAL SUMMARY, MALAYA, OCTOBER, 1958

Locality	Air Temperature Degrees Fahrenheit										Earth Temperature		Rainfall						Bright Sunshine	
	Means of			Absolute Extremes			At 1 foot	At 4 feet	Total	Most in a day	Number of Days					Total	Daily Mean	Per cent.		
	A.	B.	M n.	Max.	Min.	Lowest	Min.	Highest			Precipitation 101 in. or more	Precipitation 104 in. or more	Thunderstorm	Fog morning obs.	Gale force 8 or more					
Ipoh, Perak	91.0	73.6	82.3	95.2	71.1	84.5	77.1			in. 15.75	mm. 400.3	in. 3.86	22	18	5		hr. 181.60	hr. 5.86		
Kuala Lumpur, Selangor	89.9	73.5	81.7	92.2	71.3	85.6	75.5			7.76	197.1	2.59	19	16	8		179.20	5.78		
Sitiawan, Perak	88.0	73.3	80.7	92.8	70.6	80.1	76.1			9.69	246.1	1.72	21	15	1		172.75	5.57		
Kuantan, Pahang	89.3	72.9	81.1	92.2	90.4	83.2	75.3			13.35	339.1	2.22	23	22	12	6	169.10	5.45		
Bayan Lepas, Penang	86.2	74.4	80.8	90.1	70.8	79.7	77.0			14.44	3.66	2.46	21	19	4		160.30	5.17		
Malacca	88.3	73.8	81.1	90.8	71.8	83.9	75.4			6.90	175.3	2.05	20	15	3		175.20	5.65		
Mersing, Johore	89.3	72.2	80.7	92.4	70.6	83.6	74.4			8.16	207.3	1.72	20	18	1		183.05	5.90		
Alor Star, Kedah	87.4	73.9	80.7	91.6	70.6	78.8	76.3			10.75	273.1	2.35	23	18	1		167.75	5.41		
Kota Bharu, Kelantan	86.5	74.6	80.5	89.8	72.1	79.8	76.8			15.63	397.0	6.94	18	16	5		172.90	5.58		
K. Trengganu, Trengganu	86.8	74.0	80.4	90.9	72.6	83.9	75.4			12.73	223.3	4.04	18	16	5	1	171.85	5.54		
Singapore	88.3	74.4	81.13	92.1	70.8	82.7	76.2			11.88	301.8	2.15	21	16	7		155.00	5.00		
HILL STATION																				
Cameron Highlands, Tanah Rata, Pahang. (4750 ft.)	72.8	57.5	65.1	75.8	51.2	66.8	61.5			16.82	427.2	2.57	22	19			105.45	3.40		

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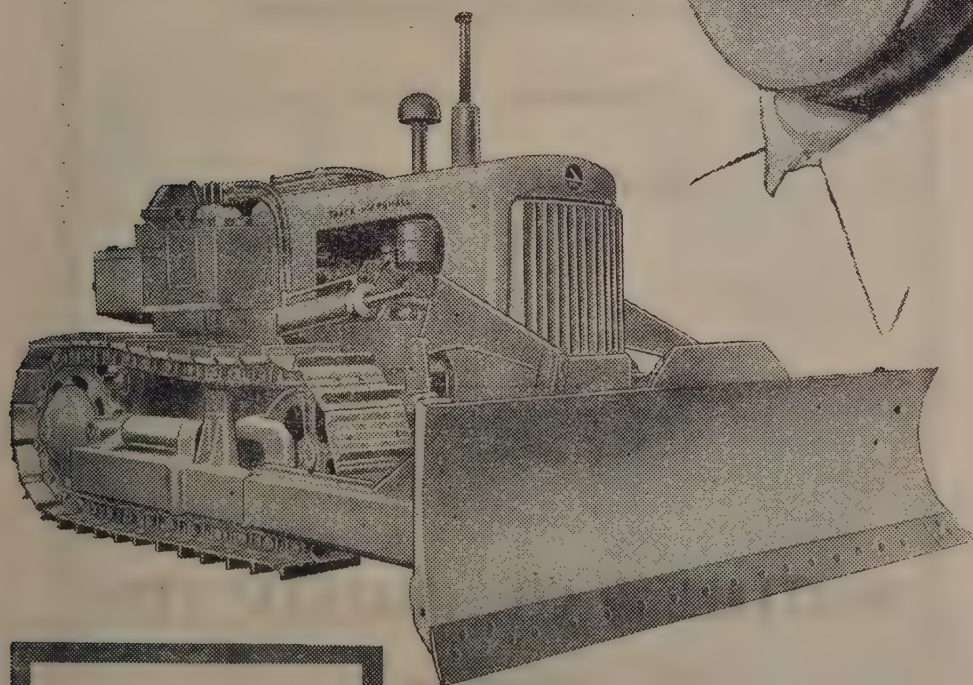
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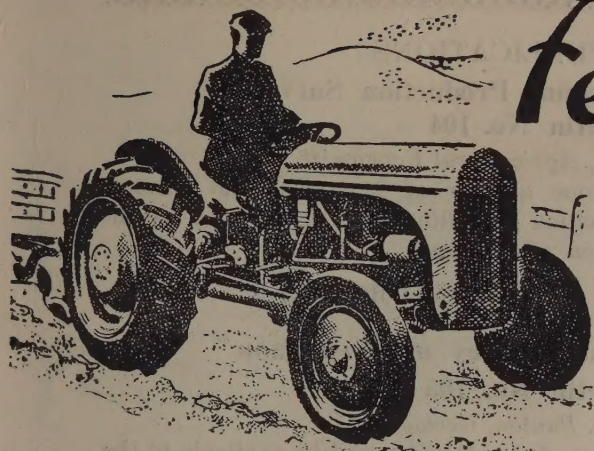
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Correspondence concerning the experiments at any of these Stations should, if it originates in Malaya, be addressed to the State Agricultural Officer, concerned; correspondence originating in any other country should be addressed to the Director of Agriculture, Federation of Malaya, Kuala Lumpur.

Wet Padi.

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